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INSTITUTION FOR
SCIENCE

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2008-2009 YEAR BOOK

Carnegie Institution
FOR SCIENCE

2008-2009







CARNEGIE INSTITUTION FOR SCIENCE

YEAR BOOK

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Department of Global Ecology

The Carnegie Observatories

Department of Plant Biology

Department of Terrestrial Magnetism

First Light & Carnegie Academy For Science Education

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2008-2009 YEAR BOOK

The President's Report

July 1, 2008 - June 30, 2009

CARNEGIE INSTITUTION FOR SCIENCE

About Carnegie

". . . to encourage, in the broadest and most liberal manner, investigation, research, and discovery, and the application of knowledge to the improvement of mankind . . ."

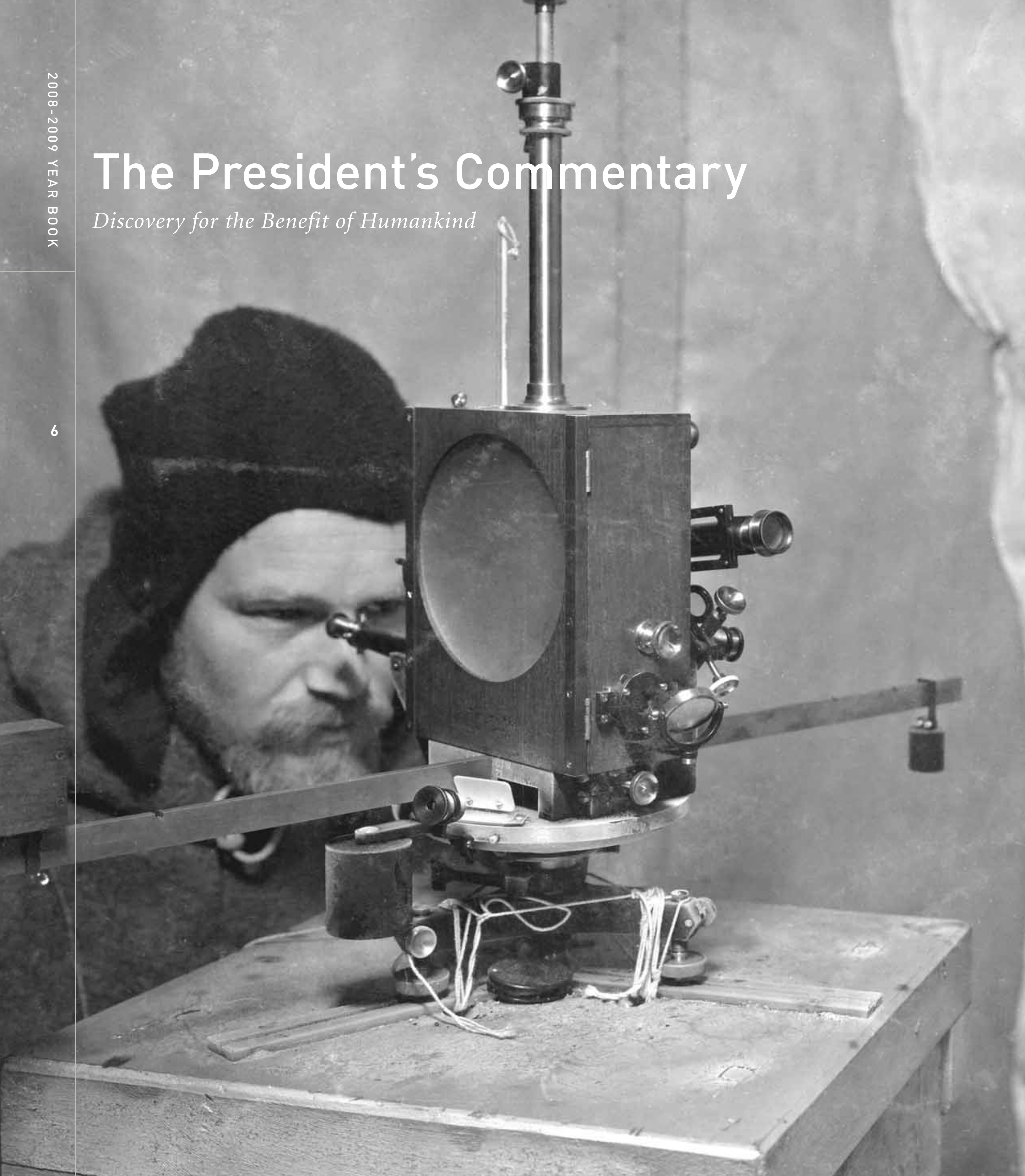
The Carnegie Institution was incorporated with these words in 1902 by its founder, Andrew Carnegie. Since then, the institution has remained true to its mission. At six research departments across the country, the scientific staff and a constantly changing roster of students, postdoctoral fellows, and visiting investigators tackle fundamental questions on the frontiers of biology, earth sciences, and astronomy.

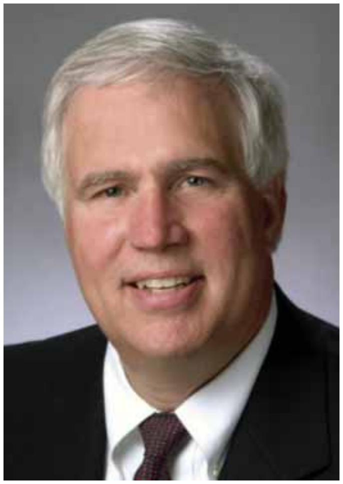
Carnegie Institution

Contents

The President's Commentary

Discovery for the Benefit of Humankind





Carnegie president
Richard A. Meserve
Image courtesy Jim Johnson

Andrew Carnegie created the Carnegie Institution with the intention that it "shall in the broadest and most liberal manner encourage investigation, research, and discovery." The institution was to pursue this purpose by endeavoring " to discover the exceptional man in every department of study. . . and enable him to make the work for which he seems specially designed his life work." Carnegie's aim was to "show the application of knowledge to the improvement of mankind."

Andrew Carnegie was remarkably prescient in his awareness of the important role of research as a catalyst for improving humankind's lot. This awareness did not arise as a matter of government policy until after World War II and the publication of *Science: The Endless Frontier* by Carnegie president Vannevar Bush. We have remained true to Carnegie's direction, although of course we now fully recognize that both women and men have important contributions to make!

Basic science, by definition, is not undertaken with the expectation that commercial products or processes will result. (These occasionally do arise and, if they do, we seek to obtain any gain through the licensing of patents.) Our output is principally scientific discoveries that expand the boundaries of human knowledge. The remarkable contribution of Carnegie scientists to the storehouse of knowledge is reflected by the wide array of scientific papers, listed elsewhere in this volume, that were published in prestigious journals over the past year.

This focus on advancing knowledge for knowledge's sake does not mean that basic research is irrelevant to human problems. The expansion of scientific understanding ultimately is reflected in products and processes that revolutionize our lives. Scientific advances have provided the foundations for remarkable advances in health care, computation, communication, food production, defense, energy production and use, transportation, and more. Moreover, economists have estimated that scientific research is the foundation for a significant portion of our economy's productivity gains.

If the past is our guide, we can have faith that research of the type conducted by Carnegie scientists will yield bountiful advances in the human condition in the years ahead. But we cannot predict what particular research project will open the door to spectacular new advances. Just as the scientists exploring quantum theory in the 1930s could not anticipate the computer and communications revolutions that their advances would enable, we cannot always know what particular basic research undertaken today will ultimately have profound impacts on humankind. Experience shows, however, that the portfolio of basic research will open doors for advances that we cannot now even imagine.

Nonetheless, while we cannot predict which projects will ultimately have widespread impact, we can often have a reasonable expectation of at least the possible immediate consequences of our research. One of the most pressing problems that the world confronts is related to the threat of climate change, which in turn is principally the product of our current dependence on fossil fuels for generating energy. Given the importance of this problem, I shall seek to array the range of research now underway at Carnegie that can impact the energy/climate problem.

We created the Department of Global Ecology in 2002 to provide an opportunity for cross-disciplinary work related to global environmental problems. Not surprisingly,

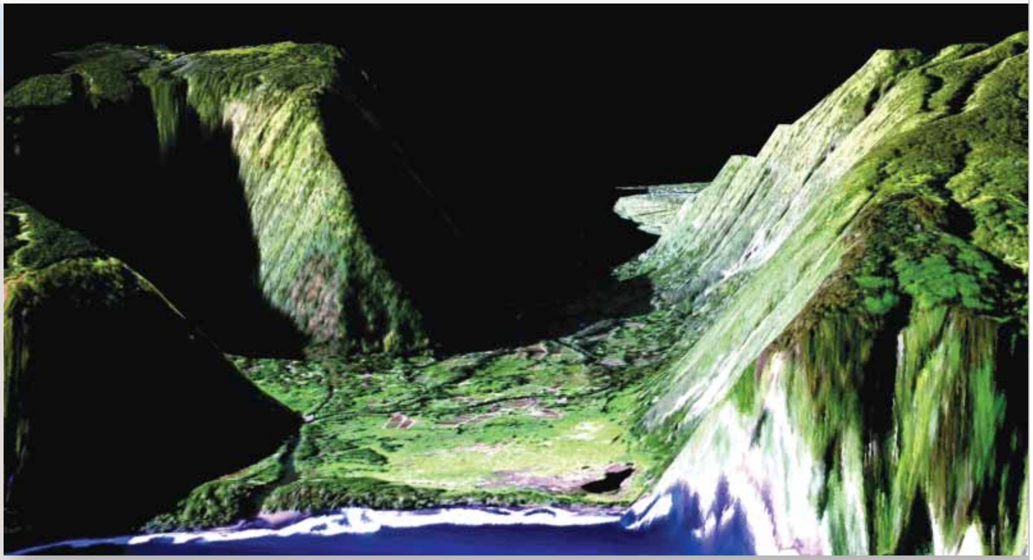
Chris Field (right), director of the Department of Global Ecology, is co-chair of Working Group II of the Intergovernmental Panel on Climate Change (IPCC). He testified at a hearing on Capitol Hill with Rajendra Kumar Pachauri, chair of the IPCC, in February 2009.

Image courtesy Senate Committee on Environment and Public Works

the department is pursuing important work related to climate change. Chris Field, the director, was one of only two Americans who were invited to Oslo to receive the 2007 Nobel Peace Prize awarded to the Intergovernmental Panel on Climate Change (IPCC). He is now working on the next IPCC assessment as the co-chair of Working Group II, which will examine impacts, adaptation and, vulnerability. Ken Caldeira is pursuing fundamental research on the acidification of the oceans resulting from increased concentrations of carbon dioxide in the atmosphere and on geoengineering, studying the various schemes to counteract the impact of increased greenhouse gases. Joe Berry and Greg Asner are monitoring of the regional effects of increases in atmospheric carbon dioxide levels. The Carnegie Airborne Observatory, which is being developed under Asner's supervision, promises to provide an important foundation for international agreements through its capability to provide a detailed inventory of the carbon in tropical forests.

We will need a variety of new energy sources to displace conventionally burned fossil fuels. Biofuels should play an important role and the scientists at our Department of Plant Biology are pursuing the basic science that will enable the wider application of this energy source. The scientific output of nearly all the research in the department could ultimately have important ramifications for energy and food production. For example, Arthur Grossman's work on algae could provide the foundations for a whole

Global Ecology staff member, Joe Berry, conducts carbon monitoring in the field.



The Carnegie Airborne Observatory (CAO) uses advanced spectro-scopic imaging and waveform laser remote sensing technologies to understand how changes in land use, climate, and natural disturbances affect the structure, composition and, functioning of ecosystems. This is a CAO image of Limahuli Hawaii.
Image courtesy CAO

new feedstock for producing important energy molecules and, indeed, his work on cell metabolism could open up the possibility of algal-based hydrogen production. David Ehrhardt's work on cellulose synthesis will bear on how plant development might be manipulated to facilitate the production of fuel from this abundant source of renewable hydrocarbons. And Zhi-Yong Wang's work on the hormones that control plant growth could provide the foundation for enhanced biomass production for food and energy.

The Geophysical Laboratory also has a range of important activities relating to energy. With a major grant from the Alfred P. Sloan Foundation, Carnegie scientists are leading an international consortium to develop a greater understanding of carbon in the Earth, including the influences of the carbon cycle on energy, environment, and climate. Among other activities, the research will define the reservoirs of carbon in the deep Earth and fluxes between them, as well as the nature and extent of microbial life at depth and the formation, stability and properties of hydrocarbons and carbon-rich fluids. In addition, with the benefit of a major grant from the Department of Energy (DOE), Carnegie established a center for Energy Frontier Research in Extreme Environments (EFree). Carnegie was one of only two non-profits to receive support under DOE's program to establish a series of Energy Frontier Research Centers. The center will use high temperatures and pressures to develop new classes

Plant Biology's Arthur Grossman (left) and Florence Mus (bottom) study properties of the single-celled alga called *Chlamydomonas reinhardtii* including how it may be used to produce significant amounts of hydrogen. The algae shown here are dyed. Purple reveals DNA and green indicates flagella.

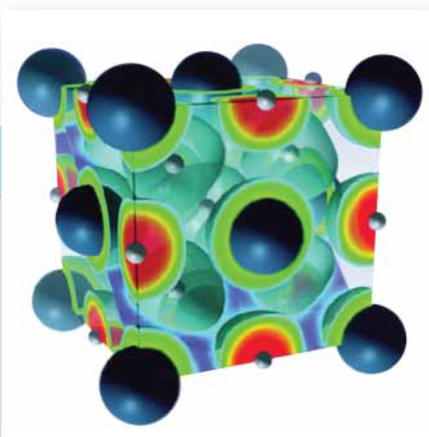
Images courtesy Arthur Grossman and Florence Mus

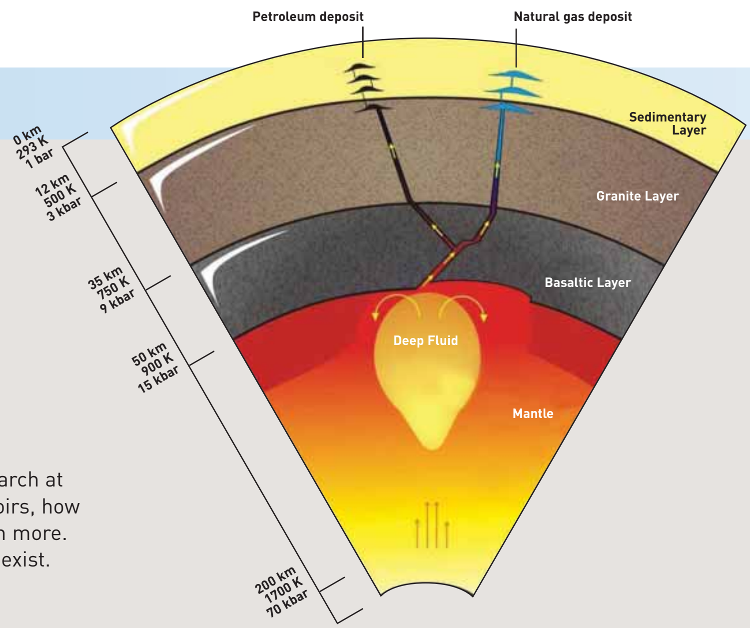
of materials of importance to energy—superconductors, superhard materials, new ferroelectrics and magnetic systems, and materials that resist chemical attack under extreme conditions. In addition, the center will seek to understand the properties of known materials in the extreme environments encountered in energy applications. The Carnegie center will build on the long and distinguished legacy of work by a wide variety of Carnegie scientists on these problems.

These projects skim the surface of the important work underway that ultimately will help define the pathway to a sustainable environment. And, of course, our work relating to energy and climate issues reflects just a partial inventory of the cutting-edge research that is underway across the institution. Our work in astronomy and planetary science, in molecular biology, and geophysics will also widen our understanding in profound ways. The supporters of the institution can be confident that we are zealously pursuing "leadership in the domain of discovery and the utilization of new forces for the benefit of man," just as our founder intended.

My commentary in these pages last year focused on the challenge that confronts the institution in responding to the severe recession that has gripped our country. In particular, I discussed the budgetary challenge that we faced as a result of threats to our major sources of revenue—the endowment, federal grants and contracts, and

The EFree grant at the Geophysical Laboratory will support research into materials important to energy, such as this dense superconducting hydride.
Image courtesy Physical Review Letters





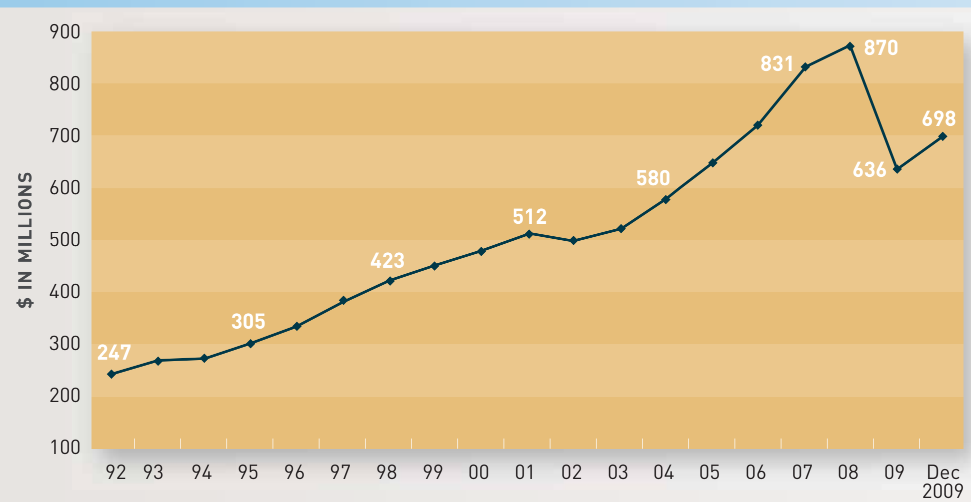
The Alfred P. Sloan Foundation grant will support research at the Geophysical Laboratory into Earth's carbon reservoirs, how it flows from the interior to the atmosphere, and much more. This cutaway shows where very deep reservoirs might exist.
Image courtesy A. Kolesnikov and V. Kutcherov

support from foundations and individuals. I indicated that, although we faced a difficult time, I was confident that Carnegie would weather the storm.

Fortunately, my optimism has proven to be justified. Although our endowment declined from approximately $870 million at June 30, 2008, to approximately $609 million on March 2, 2009, the valuation has recovered to approximately $698 million by December 31, 2009. We remain confident that our disciplined allocation to diverse investments coupled with a strategy of prudent endowment spending will allow the preservation of an endowment that will adequately support both current and future activities.

In my submission last year, I anticipated that we should prepare for the likelihood that federal grants and contracts would decline as a result of the need to constrain budget outlays. As it happened, the last federal budget was a strong one for science and the support for R&D increased further as a result of the stimulus legislation. Carnegie's inventory of federal grants and contracts grew from $29.1 million on June 30, 2008, to $35.5 million on December 31, 2009. Because these grants typically extend for several years, this inventory will provide a buffer over the next few years. Nonetheless, we anticipate constraints on federal support for science in future years as a result of the pressures to limit discretionary spending within the federal budget. We are thus planning for the likelihood that lean years for federal support may be ahead of us.

Carnegie Endowment 1992-2009



Although the Carnegie endowment experienced a decline as a result of the recession, its valuation has begun to increase to about $698 million as of December 2009.

I also noted last year that in the past foundations had been very generous to Carnegie, but that such support might be difficult to sustain given the significant decline in the valuations of those institution's endowments in 2008. We are fortunate that we have continued to receive significant foundation support. Foundation and private grants grew from $24.1 million on June 30, 2008, to approximately $34.9 million on December 31, 2009. Of course, our success in competing for both federal and foundation support is a testament to the scientific skill of our staff and the compelling nature of the science that we pursue.

Our efforts to improve the efficiency of our operations have also been successful. We have not had to lay off employees, but we have been prudent in hiring decisions. We have reduced certain administrative costs for insurance and information technology at the same time that we have improved our business operations through implementation of a new computerized accounting system, as well as other actions. Our revenue from rentals of our headquarters at P Street has increased by 50% as a result of a focused effort, and patent revenues were up in 2008 and 2009, compared to 2006 levels, by 100% and 79%, respectively. Charity Navigator, America's largest evaluator of non-profits and charities for fiscal management, has included Carnegie on its top-ten list of enterprises with consecutive highest ratings, reflecting the efficiency of our operations.

In sum, we remain financially strong in a very difficult period. Moody's Investor Service in a recent review affirmed its highest rating for Carnegie in recognition of our financial strength. Only 37 other higher-educational institutions and non-profits across the country are in this category.

Despite these signs of continuing strength, we are obliged to husband our funds prudently. In this connection, we continue to benefit from the expertise and engagement of our board of trustees. I have optimism that we will emerge from this difficult economic period with a noteworthy capacity to enrich the inventory of scientific knowledge on into the future, just as we have in the past.

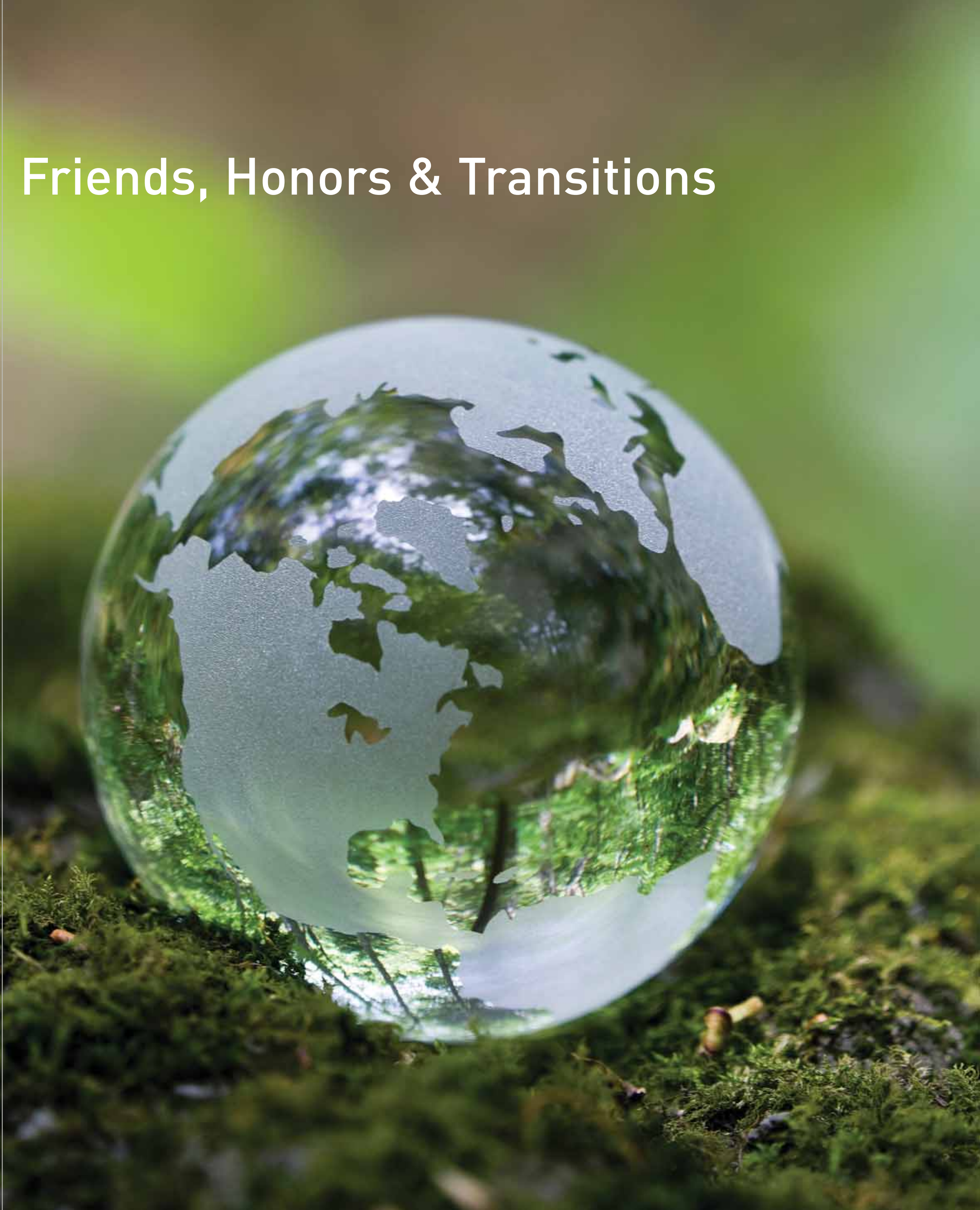
Richard A. Meserve

Moody's Investors Service

CHARITY NAVIGATOR
Four Star Charity

Carnegie has received the highest rating for sound fiscal management—four stars—from Charity Navigator, America's largest charity rating organization for eight years running. Only four organizations out of more than 5,000 have had the same rating over the same time. Moody's affirmed its highest rating of Aaa/VMIG1 on Carnegie series 1993, 2002, and 2006 bonds during the last year.

Friends, Honors & Transitions



Carnegie Friends

Annual Giving

The Barbara McClintock Society

An icon of Carnegie science, Barbara McClintock was a Carnegie plant biologist from 1943 until her retirement. She was a giant in the field of maize genetics and received the 1983 Nobel Prize in Physiology/Medicine for her work on patterns of genetic inheritance. She was the first woman to win an unshared Nobel Prize in this category. To sustain researchers like McClintock, annual contributions to the Carnegie Institution are essential. The McClintock Society thus recognizes generous individuals who contribute $10,000 or more in a fiscal year, making it possible to pursue the highly original research for which Carnegie is known.

$1,000,000 or more
Deborah Rose, Ph.D.

$100,000 to $999,999
William and Cynthia Gayden
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Robert G. and Alexandra C. Goelet
William J. Rutter

$10,000 to $99,999
Anonymous (3)
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Elizabeth Little
Steven L. McKnight
Burton and Deedee McMurtry
Richard A. and Martha R. Meserve
Al and Honey Nashman
Maxine and Daniel Singer
Paul So
Allan Spradling and
Constance Griffin
Christopher and Margaret Stone
William and Nancy Turner
Sidney J. Weinberg, Jr.

Michael Erwin Gellert

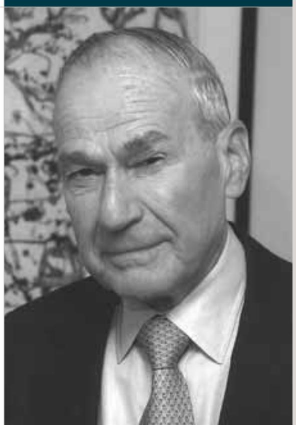
Since he joined the board of trustees in 1995, Michael Gellert has donated substantial time, guidance, and gifts to help make the last decade and a half one of the institution's most productive periods. Born in Czechoslovakia, Gellert came to the United States in 1941. He received his B.A. from Harvard University and his M.B.A from the Wharton School at the University of Pennsylvania. Following two years in the U.S. Army, he started his financial career in 1958 and in 1967 created Windcrest Partners, a venture capital and public equity investment firm.

One of Carnegie's legendary trustees, the late Bill Golden, introduced Gellert to Carnegie. From the beginning Gellert has shown particular interest in the research conducted by Carnegie scientists and has applied his extensive business expertise to advance Carnegie's mission of supporting exceptional individuals.

Carnegie has profited from the financial insights Gellert has offered as a member of the Finance and Development committees for many years. Then, in 2003, he became chairman of the board. President Meserve has marveled at Gellert's thoughtful attention to Carnegie and his constant availability to help chart the institution's course.

A member of the Edwin Hubble Society, Gellert is extraordinarily generous and typically the first to contribute to Carnegie campaigns. He then actively encourages others to do so. Over the years, he has also hosted numerous events in New York City, broadening the circle of Carnegie friends. Only three others have surpassed him in giving: Andrew Carnegie; the late William Hewlett, former Carnegie board chairman; and the late Caryl Haskins, former Carnegie president.

Carnegie is privileged to have had Michael Gellert serve on its board for the past 14 years. The institution owes much of its current vitality to him.



★ *Chairman of the Board*
Michael Erwin Gellert

Other Annual Giving

Individuals

$1,000 to $9,999

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$100,000 to $999,999
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Andrew W. Mellon Foundation
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The Rutter Foundation
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Deborah Rose

What is a chronic disease epidemiologist doing on the board of the Carnegie Institution for Science?

As a health statistician with the Centers for Disease Control, Secretary of the Board Deborah Rose collects and analyzes data about the whole population—good methodological training for seeing the big picture in other scientific arenas.

Deborah's affiliation with Carnegie began when President Emerita Maxine Singer sought her views on Carnegie's role in the community. Rose looked at everything from the neighborhood surrounding the administration building to its aging information technology. Her analysis was an important element in the decision to restore the Root Auditorium, now used for many public events, and undertake a major upgrade to the administration's computing capability. Elected to the board of trustees in 2001, she became secretary in 2003 and continues to be fascinated by Carnegie research.

Rose encouraged the use of state-of-the-art technology in the Rose Auditorium of the Maxine F. Singer Building, which houses the Department of Embryology in Baltimore. She contributed to the renovation of the classrooms in the administration building that house the Carnegie Academy for Science Education and First Light, founded in 1989 to bring an understanding and love of science to Washington, D.C., schoolchildren. Rose supports Math for America (MfA DC), which partners with Carnegie and American University to train promising mathematicians to teach secondary school students.

Recently, Rose became fascinated by the interplay between fundamental materials science research and its practical application as exemplified by the chemical vapor deposition (CVD) process developed at the Geophysical Laboratory to produce high-quality diamonds. She funded the development and acquisition of a new, high-capacity fabrication chamber that facilitates both.

Rose is a member of the Edwin Hubble Society.

★ *Secretary of the Board Deborah Rose*

Laubach Family Fund
Linden Trust for Conservation
The New York Community Trust
Northrop Grumman Foundation
Rathmann Family Foundation
Roxiticus Fund
The Weathertop Foundation
Zimmer Gunsul Frasca Architects LLP

Under $1,000

Allied Electronic Services, Inc.
Lloyd I. Biscomb Fund of Donor Trust
Chevron Humankind Program
The Doak Family Revocable Trust
Arthur and Linda Gelb Charitable Foundation
Greater Houston Community Foundation
Hartco Environmental, LLC
Hewitt Family Trust
Hicks Family Charitable Foundation
KPMG
The Lehmann Trust
Robert W. and Gladys S. Meserve Charitable Trust
Rundle-Thacher Trust
The SDLM Trust
The Seattle Foundation
R. J. Yamartino Gift Fund
Yanofsky Family Revocable Trust

Government

Over $1,000,000

National Aeronautics and Space Administration
National Science Foundation
U.S. Department of Energy
U.S. Public Health Services-National Institutes of Health

$100,000 to $1,000,000

U.S. Department of Agriculture
U.S. Office of Naval Research

$10,000 to $99,999

USDA Forest Service

Research Grant Highlights

Airborne Taxonomic Mapping System

$5.2 million from Gordon and Betty Moore Foundation to the Department of Global Ecology

To develop a next-generation spectrometer for an advanced instrument to be used in remote sensing of tropical forests

Astrobiology Institute

$7 million from NASA to the Geophysical Laboratory, Department of Terrestrial Magnetism, and Carnegie Academy for Science Education

To study the chemical and physical evolution of the origin of life in the universe, in partnership with NASA and other institutions

Brain Asymmetry

$1.6 million from National Institutes of Health to the Department of Embryology

To study how differences are established between the left and right sides of the developing brain

Carnegie Landsat Analysis System

$1.6 million from Gordon and Betty Moore Foundation to the Department of Global Ecology

To expand satellite-based forest monitoring in the Andes Amazon region on a country-by-country basis

Deep Carbon Observatory

$4 million from Alfred P. Sloan Foundation to the Geophysical Laboratory

To launch a decade-long international research effort to understand the dynamics of Earth's deep carbon

Energy Frontier Research in Extreme Environments

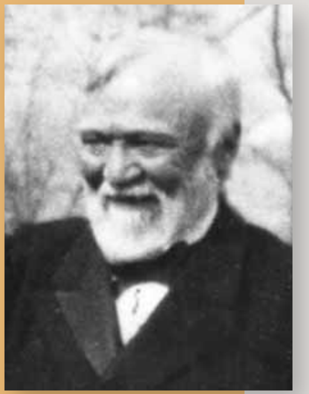
$15 million from U.S. Department of Energy to the Geophysical Laboratory

To study materials under extreme conditions with the goal of making scientific breakthroughs that are essential to large-scale replacement of fossil fuels with alternative and renewable energy

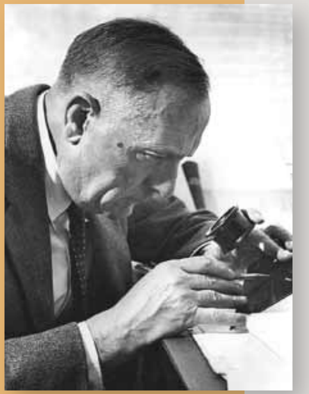
Math for America DC

$1.5 million from National Science Foundation

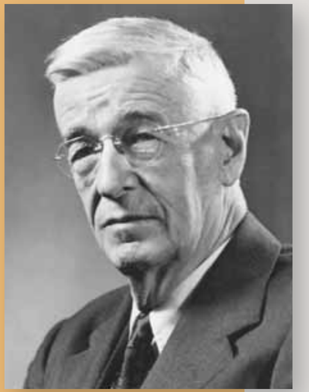
To improve math education in Washington, DC, in partnership with American University, by selecting and training fellows with math expertise to become skilled teachers



★ *Andrew Carnegie*



★ *Edwin Hubble*



★ *Vannevar Bush*

Lifetime Giving Societies

The Carnegie Founders Society

Andrew Carnegie, the founder of the Carnegie Institution, established it with a gift of $10 million. Although he ultimately gave a total of $22 million to the institution, his initial $10 million gift represents a special level of giving. In acknowledgment of the significance of this initial contribution, individuals who support Carnegie's scientific mission with lifetime contributions of $10 million or more are recognized as members of the Carnegie Founders Society.

Caryl P. Haskins*
William R. Hewlett*

The Edwin Hubble Society

The most famous astronomer of the 20th century, Edwin Hubble, joined the Carnegie Institution in 1919. Hubble's observations shattered our old concept of the universe. He proved that the universe is made of collections of galaxies and is not just limited to our own Milky Way—and that it is expanding. This work redefined the science of cosmology. Science typically requires years of work before major discoveries like these can be made. The Edwin Hubble Society honors those whose lifetime support has enabled the institution to continue fostering such long-term, paradigm-changing research by recognizing those who have contributed between $1,000,000 and $9,999,999.

D. Euan and Angelica Baird
Michael and Mary Gellert
Robert G. and Alexandra C. Goelet
William R. Hearst III
Richard E. Heckert
Kazuo and Asako Inamori
Burton and Deedee McMurtry
Jaylee M. Mead
Cary Queen
Deborah Rose, Ph.D.
William J. Rutter
Thomas and Mary Urban
Sidney J. Weinberg, Jr.

The Vannevar Bush Society

Vannevar Bush, the renowned leader of American scientific research of his time, served as Carnegie's president from 1939 to 1955. Bush believed in the power of private organizations and wrote in 1950, "It was Andrew Carnegie's conviction that an institution which sought out the unusual scientist, and rendered it possible for him to create to the utmost, would be worth while [sic] . . ." He further said that "the scientists of the institution . . . seek to extend the horizons of man's knowledge of his environment and of himself, in the conviction that it is good for man to know." The Vannevar Bush Society recognizes individuals who have made lifetime contributions of between $100,000 and $999,999.

Anonymous (3)
Bruce and Betty Alberts
Daniel Belin and Kate Ganz
Didier and Brigitte Berthelemot
Gary P. and Suzann A. Brinson
Donald and Linda Brown
A. James Clark
Tom and Anne Cori
Jean and Leslie Douglas
Bruce Ferguson and Heather Sandiford
Stephen and Janelle Fodor
William and Cynthia Gayden
Robert and Margaret Hazen
Antonia Ax:son Johnson and Goran Ennerfelt
Gerald Laubach
Lawrence H. Linden
John D. Macomber
Steven L. McKnight
Richard A. and Martha R. Meserve
Al and Honey Nashman
Evelyn Stefansson Nef
Vera C. Rubin
Allan R. Sandage
Christopher and Margaret Stone
William and Nancy Turner

Second Century Society

The Carnegie Institution is now in its second century of supporting scientific research and discovery. The Second Century Society recognizes individuals who have remembered, or intend to remember, the Carnegie Institution in their estate plans and those who have supported the institution through other forms of planned giving.

Bradley F. Bennett
Richard Buynitzky
Eleanora K. Dalton
Nina V. Fedoroff
Marilyn Fogel and Chris Swarth
Kirsten H. Gildersleeve
Robert and Margaret Hazen
Paul and Carolyn Kokulis
Gilbert and Karen Levin
Evelyn Stefansson Nef
Allan R. Sandage
Leonard Searle
Maxine and Daniel Singer
John R. Thomas, Ph.D.
Hatim A. Tyabji

**Deceased*

Members were qualified with gift records we believe to be accurate. If there are any questions, please call Mira Thompson at 202.939.1122.

Honors & Transitions

Honors

Administration

In June 2008 Yutaka Iimura, acting on behalf of Emperor Akihito, awarded trustee **John Crawford** the Order of the Rising Sun, Gold Rays with Rosette, for his work ensuring that Japanese nationals receive medical care, in their own language, at the American Hospital of Paris and for strengthening relations between Japan and other nations.

Trustee **Sandra Faber** received the 2009 Bower Award and Prize for Achievement in Science from the Franklin Institute.

Trustee **Stephen Fodor** was elected a member of the National Academy of Engineering in February 2009 for his pioneering genetics work.

Trustee **Mary-Claire King** received an honorary degree from Princeton at its June 2008 commencement.

Carnegie president **Richard Meserve** received the 2008 Philip Hauge Abelson Prize from the American Association for the Advancement of Science (AAAS) for "advancing and promoting the use of science in the service of the public interest and for his exceptional contributions to the scientific community, to policy makers, and to the general public . . ." The award is named in honor of former Carnegie president Philip Abelson.

Science writer **Alan Cutler** won the 2008 James H. Shea Award from the National Association of Geoscience Teachers for his book *The Seashell on the Mountaintop*.

Embryology

The Society for Developmental Biology awarded former department director **Don Brown** its 2009 Lifetime Achievement Award.

Staff member **Douglas Koshland** was elected a Fellow of the American Academy of Microbiology and a Fellow of the AAAS.

Facilities manager **Tom McDonaugh** received Carnegie's Service to Science Award in May 2009.

Geophysical Laboratory

The International Association for the Advancement of High Pressure Science and Technology awarded department director **Russell Hemley** its 2009 Bridgman Award.

Staff member **Bjørn Mysen** was named a Geochemical Fellow by the Geochemical Society and the European Association for Geochemistry in 2008.

Robert Hazen received the 2009 Distinguished Public Service Medal from the Mineralogical Society of America.

Global Ecology

Director **Christopher Field** was elected cochair of Working Group 2 of the United Nations and World Meteorological Organization's Intergovernmental Panel on Climate Change, the world's leading body for the assessment of climate change. He was also elected a Fellow of the AAAS.

Staff researcher **Joe Berry** was elected a Fellow of the American Geophysical Union in 2009.


★ *Sandra Faber*


★ *Stephen Fodor*


★ *Mary-Claire King*


★ *Richard Meserve*


★ *Alan Cutler*


★ *Don Brown*


★ *Douglas Koshland*


★ *Tim McDonaugh*


★ *Russell Hemley*


★ *Bjørn Mysen*


★ *Robert Hazen*


★ *Christopher Field*


★ *Joe Berry*


★ *Allan Sandage*


★ *Wendy Freedman*


★ *George Preston*


★ *Arthur Grossman*


★ *Richard Carlson*


★ *Michael Acierno*


★ *Rush Holt*


★ *Samuel Bodman*


★ *Wolf Frommer*


★ *Juna Kollmeier*


★ *Anat Shahar*


★ *Bianca Abrams*

Observatories

Staff astronomer emeritus **Allan Sandage** was inducted into the Royal Society as a foreign member in April 2009.

Department director **Wendy Freedman** shared the 2009 Cosmology Prize from the Peter and Patricia Gruber Foundation for her work on defining the Hubble constant.

Former department director **George Preston** received the 2009 Henry Norris Russell Lectureship, the highest distinction awarded by the American Astronomical Society.

Plant Biology

The National Academy of Sciences awarded staff scientist **Arthur Grossman** the 2009 Gilbert Morgan Smith Medal for his work on algae.

Terrestrial Magnetism

Staff member **Richard W. Carlson** received the 2008 Norman L. Bowen Award from the American Geophysical Union and was elected a Fellow of the American Academy of Arts and Sciences in 2009.

Michael Acierno, IT/IS Manager/Systems Engineer was awarded Carnegie's Service to Science Award in May 2009.

Transitions

Carnegie welcomed two new trustees in May 2009, Congressman **Rush Holt** of New Jersey and former secretary of energy **Samuel Bodman**.

Wolf Frommer, who had been acting director of Plant Biology, was named director in March 2009.

Astronomer **Juna Kollmeier** joined the Observatories as a staff member.

Anat Shahar joined the Geophysical Laboratory as a staff scientist.

Bianca Abrams joined Carnegie as the director of the Math for America DC program.

Research Highlights

Embryology

Deciphering the Complexity of Cellular, Developmental, and Genetic Biology


A Cellular Sidekick

A tiny sphere, lodged in the nucleus of many cells in plants and animals, houses a dizzying array of proteins and ribonucleic acids (RNAs). It may be involved in assembling and modifying the RNAs used during splicing—a step in the process by which information is copied from the DNA that makes up the genetic code onto RNA. But *exactly* what goes on in this sphere has eluded scientists for over 100 years. Variations of this so-called Cajal body, named by Joe Gall in 1999 after its discoverer, have been found in mammals, amphibians, insects, plants, and yeast. And Gall's lab is at the forefront of unraveling its mysteries.

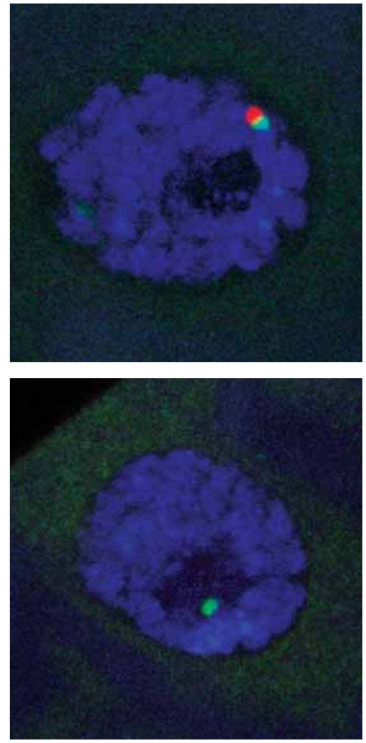
Cajal bodies in a cell's nucleus vary in number from one or a few up to 100 and can range free in the nucleus or be attached at specific locations on chromosomes. Some are associated with histone genes—histones are proteins that make up chromosomes and the structure around which DNA winds. A protein called coilin is also an important molecular player in the Cajal body. When it is made fluorescent, the protein coilin is the major marker for finding these elusive spheres.

Gall, with former Carnegie postdoctoral fellow Ji-Long Liu and colleagues, recently made some important discoveries in the fruit fly. Although coilin was not at the time known for *Drosophila*, the researchers used another marker associated with Cajal bodies in vertebrates. They were surprised to find the material in a different organelle near the Cajal body at the histone gene location. They named the new feature the histone locus body. The two bodies are often close to each other, suggesting that the Cajal body and the histone locus body carry out related functions. They also discovered, surprisingly, that *Drosophila* coilin sometimes resides in the histone locus body. This further supports a connection between the two structures, but also shows that coilin cannot be relied on to find Cajal bodies exclusively.

In a more recent study, Gall, Liu, graduate student Zehra Nizami, and visiting scientist Svetlana Deryusheva were able to identify the *coil* gene and determine the distribution of its coilin protein in *Drosophila*. They looked at a variety of tissue types and analyzed two *coil* mutants that could not produce the protein. They found that without the protein, the Cajal body was missing. But unexpectedly, the fruit flies seemed to be normal, which raises new questions about the tiny sphere. It may make RNA production more efficient or help store its components when they are in excess, but neither function may be absolutely essential.

The Mark of Zorro

Embryology's Jeff Han and colleagues are working to solve a mystery of human genetics—with the help of Zorro. To be precise, they have enlisted Zorro3, a transposon found in some yeast cells. A transposon is a sequence of DNA that jumps around the genome and is responsible for genetic change. Zorro3 is a type of transposon known as



These images show the Cajal body (red) and the histone locus body (green) in a normal fruit fly cell (top) and a mutant cell (bottom) that cannot produce the coilin protein. Without coilin, Cajal bodies are absent, but the histone locus bodies appear in both types of cells.

Image courtesy Molecular Biology of the Cell

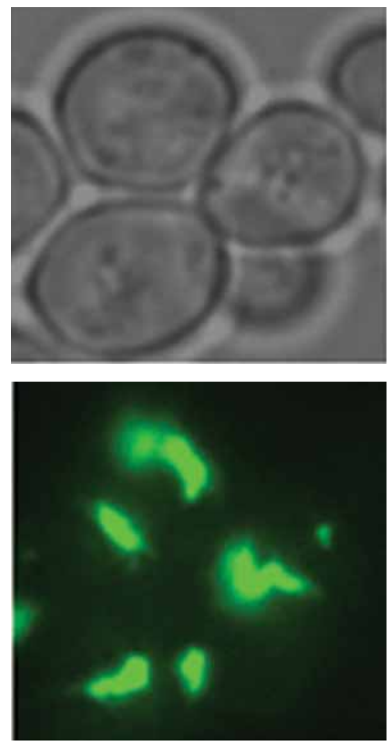
Embryology's Joe Gall (left) and predoctoral fellow Zehra Nizami pose in the lab. Ji-Long Liu identified the elusive *coil* gene in the fruit fly *Drosophila*. He found that without it, the coilin protein cannot be produced, and Cajal bodies are absent.

a LINE, or "long interspersed nuclear element." LINEs are spectacularly abundant in the human genome. About 75% of human genes contain at least one LINE insertion, and LINEs have been linked to health issues, particularly sterility. But despite their abundance, LINEs are poorly understood. How do they replicate themselves? Do they benefit their hosts, or are they just hugely successful genomic parasites?

Research on LINEs has been hampered by the lack of a good model organism for studying them. One possibility is ordinary baker's yeast (*Saccharomyces cerevisiae*), a laboratory staple that has long been a proving ground for new technologies in molecular biology. Its chromosomes are easily manipulated, with its relatively manageable genome. Unfortunately, *S. cerevisiae* happens to lack LINEs.

Han and his colleagues found a way around the problem. A distantly related yeast, *Candida albicans*, does host a LINE—namely, Zorro3. All the researchers had to do was snip Zorro3 from one yeast species and insert it into the genome of the other. It turns out, however, that *C. albicans* is a genetic oddball, using a slightly different genetic code from the universal code shared by nearly all other

Embryology, *Continued*



(Above) Research scientist Chun Dong was lead author on the *Genetics* paper reporting the transplant of Zorro3 to baker's yeast.

(Right) A modified version of the LINE-1 transposon Zorro3 was inserted into the genome of yeast cells (top). The green bodies (bottom) represent expressed Zorro3 proteins and can be used to track transposon particles in the experimental cells. The newly developed yeast model will be a powerful tool for studying LINE-1 transposons, which are extremely abundant in humans.

Images courtesy Jeffrey Han

organisms. As a result, the researchers had to reengineer Zorro3 to convert its code to the conventional code used by *S. cerevisiae*. There was another hitch as well. Because *S. cerevisiae* lacks LINEs, the researchers could not be sure that the new host cells contained factors Zorro3 needed to replicate itself. Han's team reasoned that because several closely related species host LINEs, perhaps an evolutionary ancestor of *S. cerevisiae* also hosted LINEs. If so, the associated machinery might still be present in the cells.

Their hunch turned out to be correct. The experimental Zorro3 elements transferred to *S. cerevisiae* performed admirably, even showing characteristics similar to human LINEs. With this new model system in hand, researchers can now begin to crack the secrets of these widespread but mysterious genetic elements. □

Geophysical Laboratory

Probing Planetary Interiors, Origins, and Extreme States of Matter

Getting to the Core

No one can sample the Earth's deep mantle or core, so how do scientists know what's there? Seismic surveys tell them about the elasticity and density of deep rocks and materials, while meteorites shed light on their chemical composition. However, a lot remains unknown. Now, the Geophysical Laboratory's newest staff member, Anat Shahar, is pioneering a field that blends isotope geochemistry with high-pressure experiments to examine planetary cores and the Solar System's formation.

Rocks and meteorites consist of isotopes—atoms made up of the same number of protons but different numbers of neutrons—which contain chemical fingerprints of long-gone eras. The lighter isotopes, with fewer neutrons, partially separate from heavier isotopes in a process called fractionation. The different ratios of these isotopes can reveal the physical and chemical changes these materials have undergone.

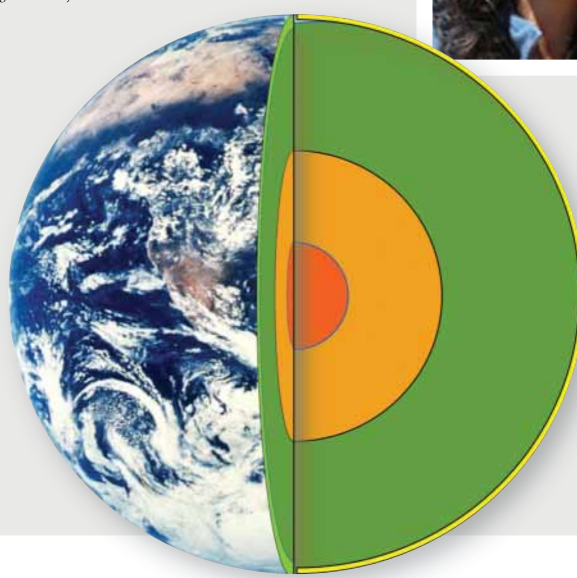
Comparing seismic measurements and information on materials, researchers know that Earth's outer core is not pure iron and nickel; something lighter is there. One candidate is silicon, the most abundant element in the crust. Shahar and her colleagues have found a way to test the silicon hypothesis. They developed lab techniques to define how isotopes of silicon and iron separate between metals characteristic of the core and silicate of the mantle under Earth-forming high pressures and temperatures. These results are compared with isotopes found in rocks on Earth and the most primitive meteorites called chondrites. Chondrites contain tiny grains of dust from the period when the Solar System began to coalesce.

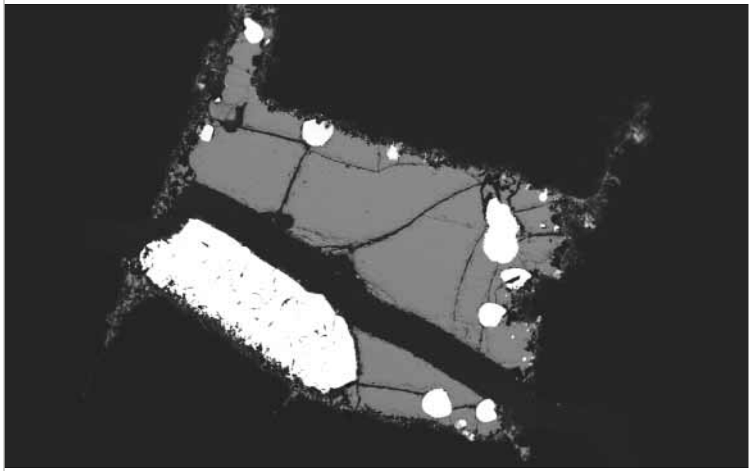
Shahar and team developed their new techniques based on a method called three-isotope exchange—where an isotope is spiked on one of two reactants. They are the first to use it under high temperatures and pressures to

(Right) The Geophysical Laboratory's newest staff scientist is Anat Shahar.

(Below) This cutaway of the Earth shows the top crust (yellow), mantle (green), outer core (light orange), and inner core (dark orange).

Images courtesy Anat Shahar





This image shows the results of an experiment from the piston cylinder apparatus that represents what goes on inside a planet. The brighter spots are metal with silicon dissolved in it to represent the core. The grayish part is silicate melt, which represents the mantle. The experiment was done at high pressure and temperature and then quenched to ambient conditions. The result freezes what was happening at those conditions.

Image courtesy Anat Shahar

investigate silicate and iron melt interactions. If some silicon sank to the core during the Earth's formation, the amount might be deduced from the differences in silicon-30 and silicon-28 between Earth rocks and meteorites. The scientists tested the hypothesis by examining separation values in the lab for proxy materials. They looked at silicon separation between silicate (mantle material) and iron-rich metals representative of the core under pressures of 9,900 times sea-level pressure and temperatures of 3270°F, and determined reference values. When combined with previous measurements of Earth rocks and meteorites, they found that the core could contain as much as 6% silicon by weight. They also demonstrated a powerful new research tool.

Tracing the Sources of Oddball Meteorites

When a meteorite found in Antarctica turned out to be unusually rich in oligoclase, a feldspar mineral, researchers explained it as a partial melt from a parent body that, unlike young Earth, never melted globally and failed to separate a metal core. But which body? Nothing comparable could be found in museum collections. And when the meteorite Almahata Sitta was spotted in space on a collision course with Earth, it prompted a worldwide astronomical alert. But after it was finally collected in the Nubian Desert and studied, researchers were not sure just what it was. It was too porous, too carbon rich, too heterogeneous in its magnesium/iron ratio to fit precisely into existing classification schemes.

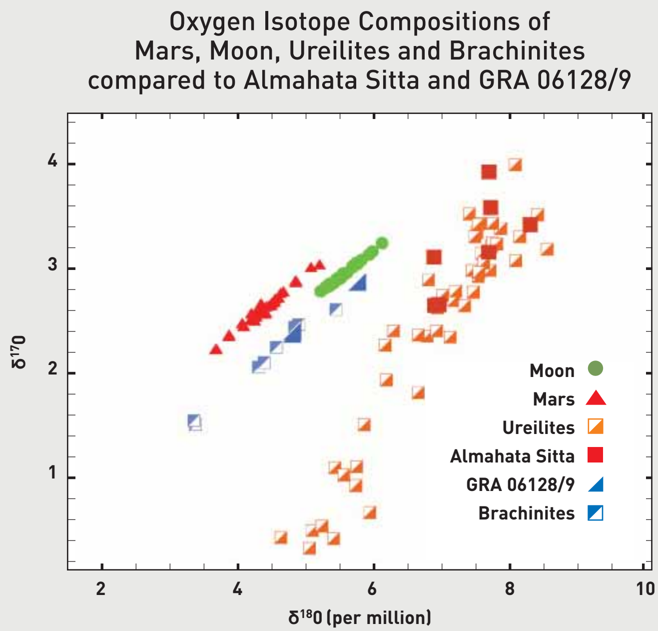
In cases like these, puzzled meteorite researchers turn to oxygen isotope analyses. For both meteorites, Geophysical Laboratory geochemist Douglas Rumble was called on to analyze milligram samples for $^{17}O/^{16}O$ and $^{18}O/^{16}O$ isotope ratios. Rumble compared the meteorites' ratios with those of three potential sources: Moon, Mars, and a family of meteorites known as brachinites. These planetary bodies, heated by the decay of radioactive elements, equilibrated their oxygen isotopes through melting, mixing, and crystallization. On a graph their isotope ratios define parallel linear trends, termed mass-fractionation lines, with slopes of 0.52. A meteorite's ratios will usually fall on one of these mass-fractionation lines, identifying its source.

The ratios of the Antarctic meteorite matched the brachinite analyses, despite a distinct mineralogy that resembles that of Andean volcanoes instead of the mantle-like mineralogy of known brachinites. The meteorite likely derived from the brachinite parent body

(Above) Smoky trails in the sky above Sudan were captured by a cell phone camera after the Almahata Sitta exploded before impact.

Image courtesy Mohamed Elhassan Abdelatif Mahir, Muawia H. Shaddad, and Peter Jenniskens

(Right) The Geophysical Laboratory's Douglas Rumble performed oxygen isotope analyses on the meteorite samples.



by a partial melting process that enriched it in feldspar.

Almahata Sitta shares the compositional range of a class of meteorites called ureilites, which scatter widely on the isotope plot with an overall slope of approximately 1.0. This trend unambiguously distinguishes ureilites from all other planetary bodies. Unlike Earth, Moon, or Mars, the ureilite parent body scarcely melted at all and so failed to equilibrate on a mass-fractionation line.

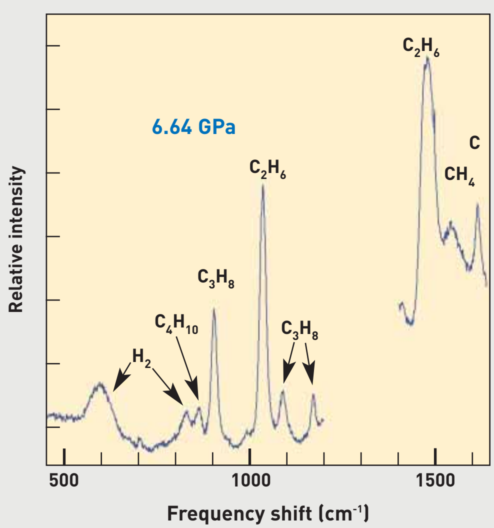
Rumble's work on these meteorites illustrates how subtle differences among the isotope ratios reveal the extraordinary variety of distant planetary bodies during their formation, and emphasizes the uniqueness of our own hospitable planet.

(A plot of $^{17}O/^{16}O$ and $^{18}O/^{16}O$ isotope ratios reveals a meteorite's source. Ratios of the Moon, Mars, and a family of meteorites known as brachinites define parallel linear trends, termed mass-fractionation lines, with slopes of 0.52. Despite its distinct mineralogy, the Antarctic meteorite GRA 06128/9 matched the brachinite analyses, and likely derived from the brachinite parent body by a partial melting process that enriched it in feldspar. Almahata Sitta shares the compositional range of a class of meteorites called ureilites. Unlike other source bodies, the ureilite body never equilibrated on a mass-fractionation line, so the points scatter widely on the plot.

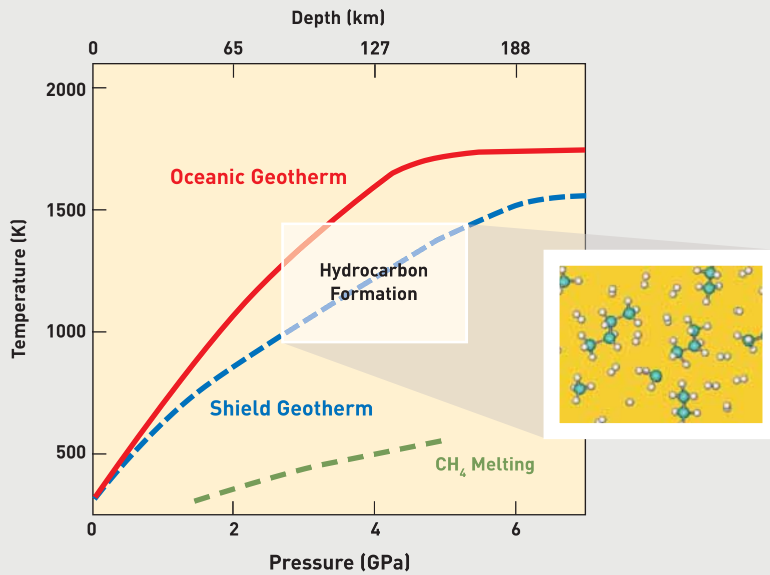
Images courtesy Douglas Rumble

Geophysical Laboratory, *Continued*

RAMAN SPECTRA



HYDROCARBON FORMATION



Could deep carbon provide a source of hydrocarbons? Experiments by GL scientists have shown that under mantle pressures and temperatures, methane can disassociate and recombine to form heavier hydrocarbons. The image above left shows Raman spectra of the reaction products quenched after heating. The image above right depicts pressure–temperature range corresponding to hydrocarbon formation in laser-heating experiments compared with the model oceanic and shield geotherms and the methane melting line. The inset is an artisitc representation of dissociation products. Hydrocarbons forming in the upper mantle could be transported along deep faults to shallower depths in the Earth's crust. *Images courtesy Alexander Goncharov*

New Frontiers for Energy, Carbon Research

Carnegie has a long tradition of fostering transformational discoveries in fields spanning different disciplines. This year the Geophysical Laboratory capitalized on its legacy of research on materials under extreme pressures and temperatures to embark on two new interdisciplinary research ventures.

The U.S. Department of Energy selected the lab to host one of 46 Energy Frontier Research Centers, providing a five-year, $15 million award for the Energy Frontier Research in Extreme Environments Center (EFree). EFree will be directed by Ho-kwang (Dave) Mao and GL director Russell Hemley.

EFree brings together an unprecedented alliance of 35 key scientists from Carnegie, national labs, and universities for this research. The creation of EFree will allow GL

To mimic the high-pressure conditions of the deep Earth, scientists squeeze samples in a diamond anvil cell between two single-crystal diamonds, such as these diamonds fabricated at the Geophysical Laboratory by chemical vapor deposition. *Image courtesy Yufei Meng*

scientists to expand their fundamental studies of materials under extreme conditions while at the same time focusing research on scientific problems relevant to major energy challenges facing the world. EFree researchers will use high pressures and temperatures to create novel materials, including new classes of superconductors, superhard materials, high-energy density and hydrogen storage materials, and new ferroelectrics and magnetic systems—all of which have important applications for new energy technologies.

The Alfred P. Sloan Foundation has awarded Carnegie a $4 million grant over three years to initiate the Deep Carbon Observatory—an international, decade-long project to investigate the nature of carbon in Earth's deep interior. With GL's Robert Hazen as principal investigator, the observatory will coordinate the efforts of hundreds of researchers from more than two dozen countries.

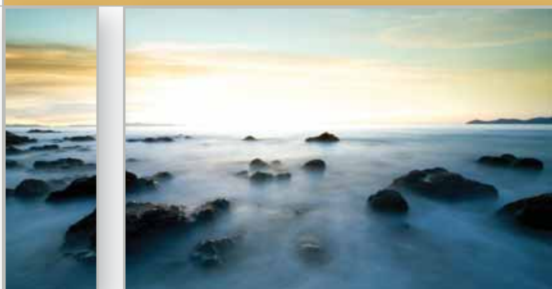
The observatory's multidisciplinary research will focus on Earth's poorly understood deep carbon cycle and the possible influence this cycle may have on critical societal concerns related to energy, environment, and climate. Among the basic unanswered questions to be addressed by observatory scientists are the quantity and nature of carbon stored within the deep Earth and the fluxes between reservoirs, as well as the question of deep, abiotic hydrocarbons—those not derived from living cells—and the extent of deep microbial ecosystems, which by some estimates rival the total surface biomass.

Taken together, these two ambitious research initiatives will launch materials and Earth science in new directions, and put Carnegie at the center of two exciting new multidisciplinary fields. □

The DOE-funded EFree Center held its first workshop on September 11. More than 40 scientists attended. The partners discussed resources at their facilities and future collaborations. *Image courtesy Susana Mysen*

Global Ecology

Linking Ecosystem Processes with Large-scale Impacts



Can California Wine Take the Heat?

California wine accounts for over 90% of U.S. wine production and is the country's most valuable fruit crop. But wine production, like much of agriculture, is threatened by global climate change. Not only are rising temperatures likely to reduce grape harvests, but the quality of wine grapes is famously sensitive to climate. On the other hand, grape cultivation is a highly managed agricultural practice, often operating at a high profit margin, so grape growers may have more resources for adapting to climate change than other types of farmers. So what are the prospects for California wine in the face of global warming?

Kimberly Nicholas Cahill was a graduate student in Chris Field's lab and is now at the University of California-Davis. She combined research on the chemistry of Pinot Noir grapes with extensive interviews with winegrowers in the North Coast wine country to assess both the vulnerability of wine quality to climate change and the potential for winegrowers to adapt to change.

In her field study, Cahill found that, depending on the season, warm temperatures could either increase or decrease the concentration of the phenolic compounds that affect wine quality. Unfortunately, climate models project that California will suffer greater warming during the summer, while the grapes are ripening. Excess heat at that time hurts wine quality.

To adapt to impending climate change, winegrowers have both long- and short-term strategies available. To deal with rising heat in the short term, they can cool plants through irrigation or shading. Longer-term strategies

[Above] Vineyards have been part of the California for more than two centuries, but climate change in the upcoming century threatens both the quantity and quality of California wine.

[Right] Kimberly Nicholas Cahill was a graduate student in Chris Field's lab.

Image courtesy Chris Field

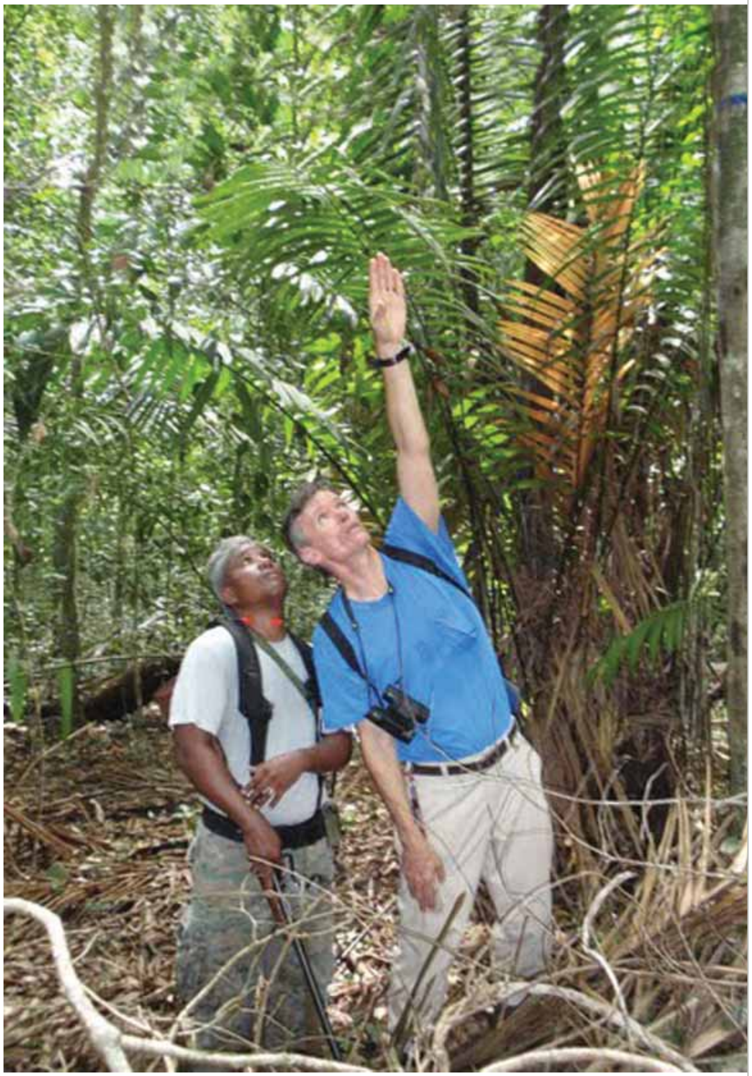
include growing new, heat-resistant varieties of grapes, or even relocating vineyards to cooler areas. The strategies all have their limitations, however. New, unfamiliar grape varieties may not be accepted by consumers. Relocating a vineyard is not only expensive, but also impractical for premium wines closely linked with the *goût de terroir*—taste of the earth—of their areas of cultivation.

Wine vineyards have been part of the California landscape for more than two centuries. How will they fare in the coming century? Overall, Cahill sees a fairly high capacity for adaptation, but adaptation can only do so much. To keep the wine flowing, we need to cut back on the carbon dioxide emissions that are driving climate change.

A Tropical Revolution

The Greg Asner lab's Spectranomics Project came out of the starting gate at lightning speed this year. It is the first-ever aerial biodiversity mapping system, and it promises to revolutionize monitoring, conservation, and management of critical tropical forests. Despite the logistical, environmental, and bureaucratic challenges of working at 60 remote sites in eight rain forest nations, the group collected more than 3,000 canopy plant species its first year. Its project goal is 10,000 species. Until now, there has been no database linking taxonomic, chemical, and spectral properties of canopy plants. The new system will allow aerially obtained spectral signatures to be compared with the database and thereby to map various species' characteristics—critical information for understanding how human use and climate change affect biodiversity.

Analyzing wavelengths of reflected light—spectra—from plants yields species-specific chemical signatures. The team uses the fixed-wing Carnegie Airborne Observatory

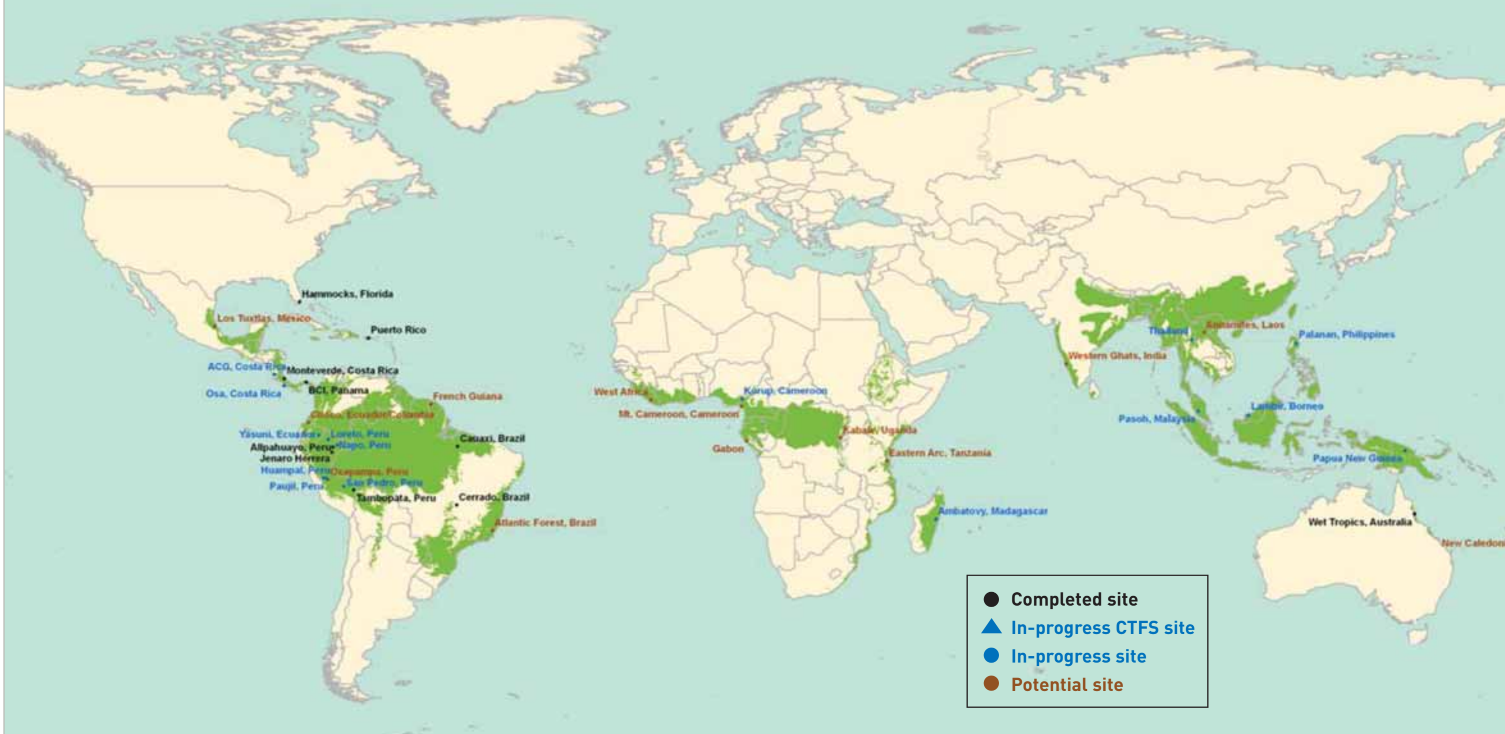


Collecting samples from the treetops requires a variety of innovative approaches, including shooting them down. This shooter gets instructions from Smithsonian collaborator Joe Wright.

Image courtesy Asner lab

Global Ecology, *Continued*

SPECTRANOMICS COLLECTION SITES



The Asner team has a global network of botanical sites along three major axes of species variation. Current and planned research areas spotlight biodiversity hotspots in the Pacific islands, Australasia, Amazonia, Africa/Madagascar, Indonesia, and Central America. Sites are indicated on the map. *Image courtesy Asner lab*

(CAO) to inventory rain forest vegetation over nearly 40,000 acres per day. But it has lacked a library for interpreting new signatures and linking sensor data to species spectra. In phase one of the project, it is developing the database for this spectral comparison.

Many processes, scores of people, and collaborating organizations are involved worldwide. The group has developed an array of new protocols and specialized equipment. It obtains permits from foreign governments, surveys and identifies species, collects on-ground leaf spectra and samples, and then prepares and archives the specimens for shipment and high-volume analysis at Global Ecology.

In addition to its globe-trotting surveys, the team is

developing computer algorithms to extract taxonomic information from the spectra. It has also created a Web portal so that anyone will be able to view, search, and organize species data by geography, chemistry, botany, and spectra.

Asner has already embarked on phase two of the project—developing a sensor called the Airborne Taxonomic Mapping System (AToMS). It will be one of the most advanced remote sensing systems ever built, far exceeding the capabilities of both the original CAO and current space-based sensors. It will fly on fixed-wing aircraft. Carnegie and the Smithsonian Tropical Research Institute (STRI) have agreed that, for operations in the New World tropics, AToMS will be based at the STRI hangar in Panama, providing complete access to the Caribbean and to Central and South America. For more see http://spectranomics.ciw.edu/. □

Once the team collects samples, it catalogs and processes them on-site.
Image courtesy Asner lab

Observatories

Investigating the Birth, Structure, and Fate of the Universe

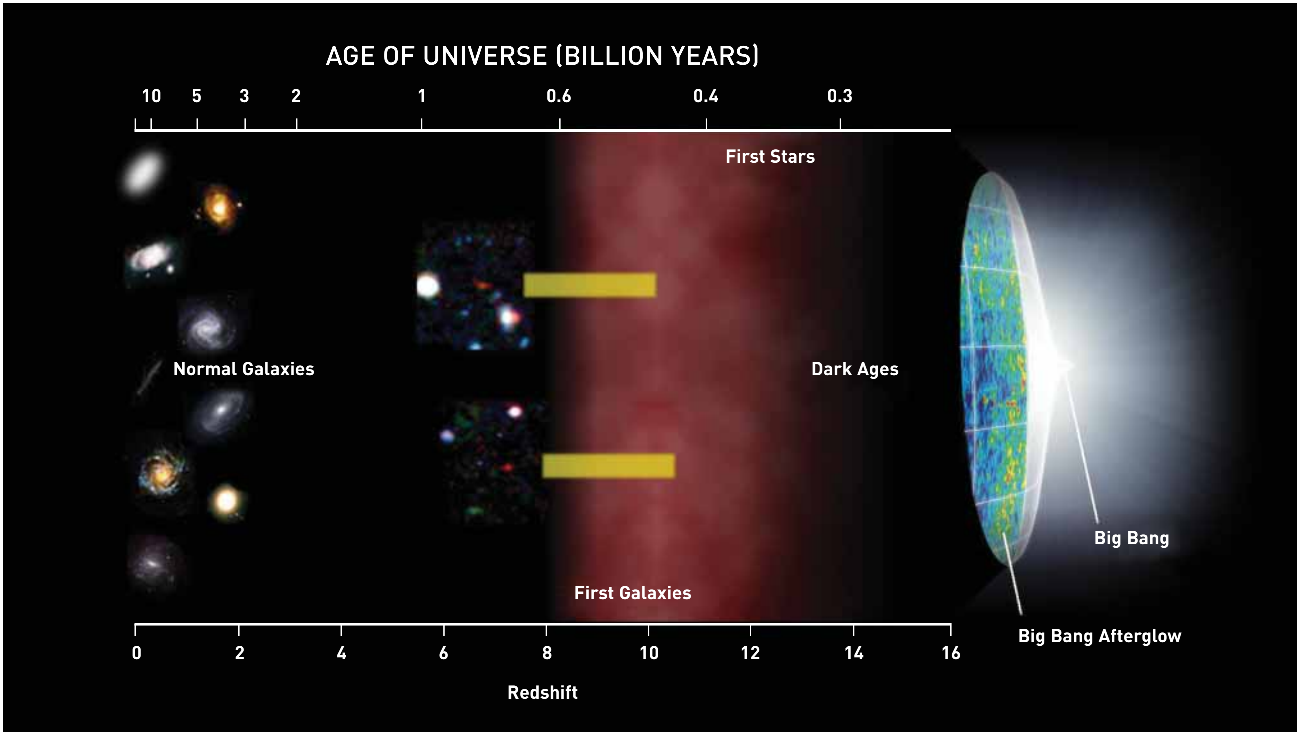

Turn On the Lights—the Party's Starting

The Big Bang created a hot, murky universe 13.7 billion years ago. About 300,000 years later, temperatures cooled, electrons and protons joined to form hydrogen, and the universe cleared. Some 200 million to 1 billion years after the Big Bang, neutral hydrogen began to form quasars, stars, and the first galaxies. The resulting intense energy reionized the gases, again making the universe partially opaque. Astronomers call this era the reionization epoch. Technology allows astronomers to observe to about 1 billion years post–Big Bang after the end of the reionizaton epoch.

Using new instrumentation and techniques, Alan Dressler, Patrick McCarthy, and colleagues Crystal Martin (U.C. Santa Barbara) and Marcin Sawicki (Saint Mary's University) are exploring this epoch. They are testing the theory that hot, young stars in the first galaxies provided the energetic light that reionized the gaseous intergalactic medium. This study will provide important information about the first galaxies and their effect on the gas that started the evolution from a simple universe to a staggeringly complex one.

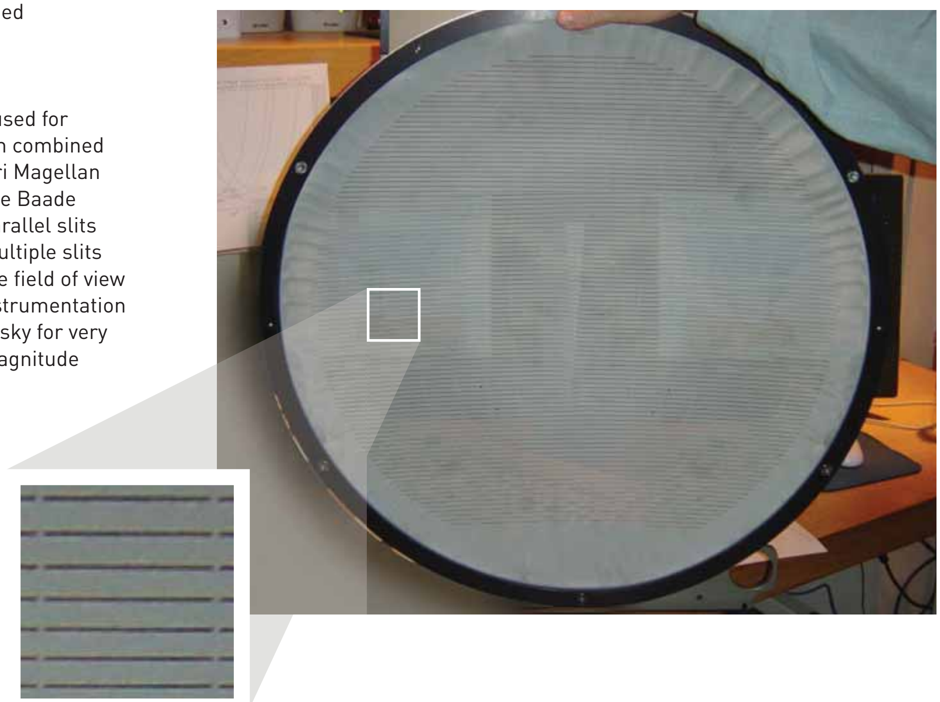
Scientists look for signatures of hydrogen from this era called Lyman-alpha emission, which is light from hydrogen transitioning from its first excited state to its lowest state. In 2008 Dressler, McCarthy, and team reported on three Lyman-alpha sources from a billion years after the Big Bang using new multislit spectroscopy combined with a narrowband filter of the Inamori Magellan Areal Camera and Spectrograph (IMACS) on the Baade telescope at Carnegie's Las Campanas Observatory in Chile. They used a "venetian blind" mask to search the sky, and the spectrograph to disperse light over a narrow band of the infrared spectrum. This combination increased the contrast of very faint sources, allowing them to probe an order of magnitude more deeply than ever before.

The first three Lyman-alpha sources confirmed that the relatively bright sources could not have supplied enough energy for reionization. More importantly, it demonstrated that narrowband spectroscopy can discover extraordinarily faint sources. Ian Thompson and Greg Burley thus built a much more sensitive CCD camera that enabled the IMACS team to improve image quality significantly. During the course of a new search begun in April 2008, the team found more than a hundred Lyman-alpha candidates. They eliminated about half as interloping foreground objects, leaving 30 to 50 likely emitters. The large number of objects, some five to 10 times fainter than the original three, could provide the energetic photons needed to ionize the intergalactic gas. The data imply that such faint galaxies began ionization a half a billion years earlier than predicted. But detailed studies await exploration by facilities such as the Giant Magellan Telescope.



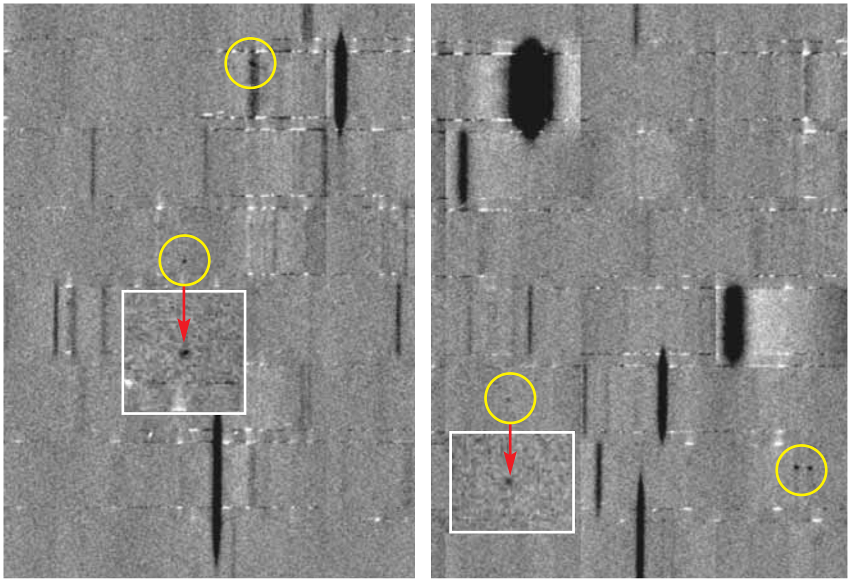
(Above) This diagram shows a simplified evolution of the universe.

Image courtesy Ivo Labbé



(Right) This "venetian blind" mask is used for multislit spectroscopy, which the team combined with a narrowband filter of the Inamori Magellan Areal Camera and Spectrograph on the Baade telescope. The mask has about 100 parallel slits and looks like a venetian blind. The multiple slits allow light from different objects in the field of view to pass into the spectrograph. This instrumentation allows the astronomers to search the sky for very faint sources and probe an order of magnitude more deeply than before.

Image courtesy Alan Dressler



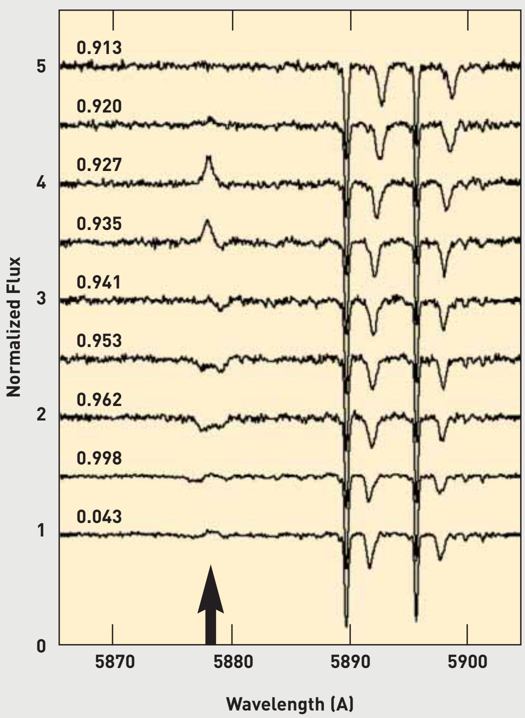
The red arrows on these images from the new instrumentation indicate two of the Lyman-alpha candidates. The objects in the circles show foreground emission objects.
Image courtesy Alan Dressler

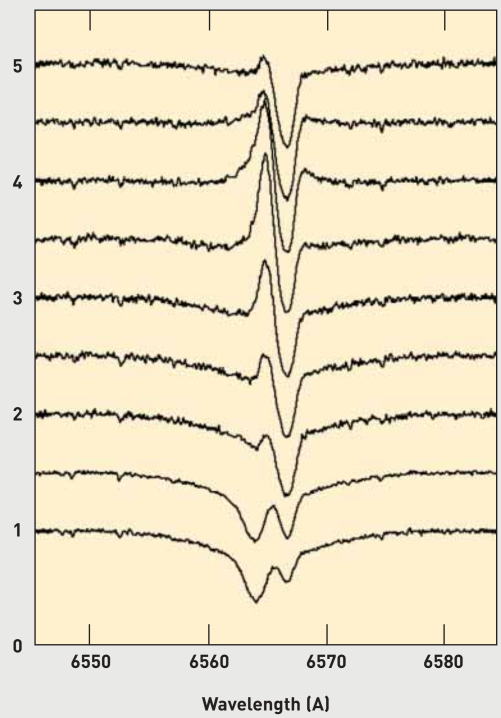
Fleeting Glimpses of Glowing Helium

Twice a day, more or less, the tenuous outer atmospheres of giant, pulsating RR Lyrae stars are propelled outward by shock waves generated in their interiors. The outer layers cool as they expand and then fall back, to be met by the next shock. And so it goes. All the oldest stars in our galaxy become RR Lyrae stars late in their lives, pulsating rhythmically for about one percent of their lifetimes (some 100 million years) before going to the white-dwarf graveyard. Understanding the behavior of these stars is important because they are used as “standard candles” to measure distances in the universe. Previously, only hydrogen emission had been observed during these shock events. George Preston, director emeritus of the Observatories, discovered that they fleetingly emit the light of helium as well, a finding that challenges existing pulsation models.

Changes in the temperature and density of RR Lyrae stars are ascertained minute by minute by measuring the brightness and motion of the surface layers as shocks pass through them. Four years ago George Preston began to look at shocks in 10 stars, using a spectrometer at the du Pont telescope. Last March, while observing the shock phenomenon in one of the stars, he noticed a small excess of light in the yellow region of the spectrum and quickly realized that it was being produced by glowing helium, the second lightest and second most abundant element. Then, to his astonishment, the emission peak was replaced after 15 minutes by exceedingly weak absorption dips produced by helium in the infalling and outrushing gas. Preston then examined hundreds of spectra obtained during previous expeditions to Las Campanas and found dozens of examples of helium lines in the 10 stars he had been observing. He had missed the phenomenon year after year because it is so short-lived, and because he wasn’t looking for it. Others had missed it as well.

Before this research, only hydrogen emission lines had been observed during these shock events. Helium is important because much higher temperatures (stronger shocks) are required to excite it. This discovery means that existing models for the pulsation behavior of these stars will have to be revised. The work also raises the hope that one day helium emission can be used to estimate helium abundances in these stars, a crucial parameter in the calculations that are undertaken to model star behavior over time. □





(Above left, top to bottom) Spectra of the RR Lyrae star RV Octantis were obtained at 7-minute intervals during a shock event in 2007. Helium emission is located in the third and fourth spectra above the vertical arrow. Proceeding down, the emission is quickly replaced by exceedingly weak absorption dips, which persist for an hour or so. (Above right) Emission at the H-alpha hydrogen line (at 6562.8 Angstrom) is much stronger than the helium emission because hydrogen is more abundant and is more easily excited in the shock. Unlike in the case of helium, a strong dip produced by infalling gas overlies the H-alpha hydrogen emission in all of the spectra—data that are grist for the theorist's mill.

(Below) Observatories Director Emeritus George Preston stands in front of the du Pont telescope at Carnegie's Las Campanas Observatory.

Image courtesy George Preston

Plant Biology

Characterizing the Genes of Plant Growth and Development

An Arms Race in Yellowstone

In Yellowstone National Park, predator and prey have engaged in an ancient duel for eons. Grizzly versus moose on the riverbank? Wolf versus elk in the snow-filled woods? In fact, this conflict is much older: virus versus bacteria in the bubbling hot springs.

The colorful microbial mats such as those in Yellowstone's famous hot springs are among the oldest ecosystems on Earth. Bacteria, archaea, and viruses create these complex layered communities, which thrive in extreme environments, such as hot springs and hypersaline lagoons. Studying them not only gives clues to the early evolution of life on Earth, but also, because the microbes evolve so rapidly, can give researchers glimpses of evolution in action.

Plant Biology's Devaki Bhaya and colleagues have uncovered an evolutionary "arms race" between photosynthetic cyanobacteria (formerly called blue-green algae) and the viruses that prey on them. The saga is revealed in the heat-loving cyanobacterium named *Synechococcus*, which contains arrays of CRISPRs (Clustered Regularly Interspaced Short Palindromic Repeats) and an associated group of genes that work together as a potent antiviral defense system.

The researchers used an approach known as metagenomics, in which genetic material from environmental samples is sequenced without the need for laborious culturing of individual microbial strains. They found that the CRISPR arrays in *Synechococcus* include a large number of unique sequences, some of which were similar to certain viral genes. Analyzing these sequences within both the cyanobacterial and viral populations suggests that the genetic content of both is changing rapidly. These results can

Members of Bhaya's team are making measurements and collecting samples from the Octopus Spring at Yellowstone National Park. The microbial mats in the hot spring are the site of an evolutionary "arms race" between cyanobacteria and viruses.

Plant Biology's Devaki Bhaya at Yellowstone National Park, winter 2008.

Images courtesy Devaki Bhaya

be viewed as a snapshot of the ongoing arms race between the attacking viruses and the defending cyanobacteria. As the virus populations mutate and evolve new genetic sequences to evade detection by the cyanobacterial defense system, the cyanobacteria need to acquire these sequences to help keep the viral attackers at bay. Intriguingly, the genes associated with CRISPR arrays encode proteins that have some similarity to those used to "silence" genes in plant and animal genomes.

Now that Bhaya's group has identified this rapid co-evolution of predator and prey in the natural environment, they plan to dig deeper to put together a comprehensive picture of an evolutionary contest that has raged for billions of years.

Confidence in Your Genes?

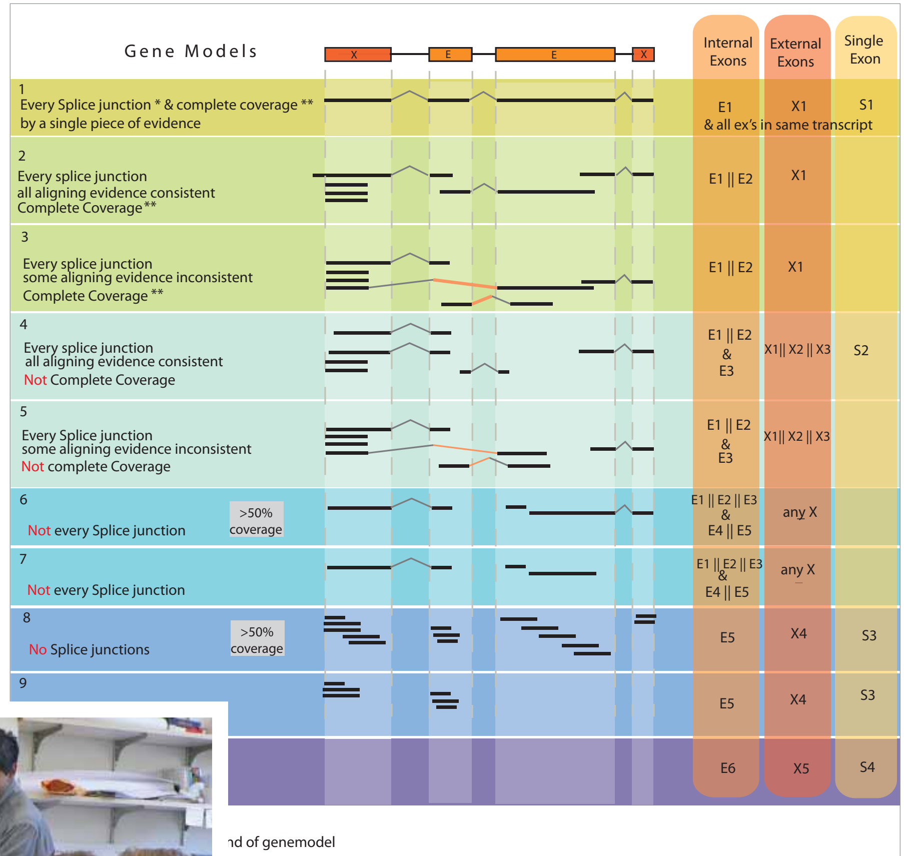
A plant the size of a golf ball has some 27 thousand protein-encoding genes, significantly more than the 20 thousand or so confirmed protein-encoding genes in humans. So what do the plant genes do? To find out, scientists use the tiny cabbage relative *Arabidopsis thaliana* to study many of the basic life processes that all plants share. Eva Huala and colleagues have been combing through the roughly 30,000 research articles about *Arabidopsis* and presenting the results in an online database called TAIR (The Arabidopsis Information Resource), http://arabidopsis.org/. TAIR, offering a large body of information on the functions carried out by many of the genes and the proteins they make, is one of the most popular biological databases in the world.

Scientists at TAIR have been working hard to keep the list of genes in the genome sequence, first published in 2000, up to date with recent discoveries. In the most current genome release, TAIR9, made public on June 19, 2009, the genome annotation team led by David Swarbreck added a confidence ranking system for each gene to reveal the experimental support for the structure of a given gene. This ranking will enable scientists working on other more recently sequenced plant genomes to know which *Arabidopsis* gene structures are reliable enough to serve as predictors of the structure of genes in other plant genomes. The TAIR9 release contains 27,379 protein-encoding genes, 926 pseudogenes (probably producing nonfunctional proteins), 3,901 genes located within transposable elements (which move around the genome), and 1,312 genes encoding various kinds of RNAs. This yields a total of 33,518 genes in all, not bad for a golf ball-sized plant.

Arabidopsis research data are important in many areas of plant biology, including crop improvement and population biology studies, as well as in basic research on plant growth and development. The TAIR Web site continues to increase in popularity with researchers around the world. On May 5, 2009, TAIR logged its 100,000,000th page view and currently averages about 35,000 different visitors to the site each month.

Eva Huala is the director of The Arabidopsis Information Resource (TAIR), one of the most widely used biological databases in the world.
Image courtesy Eva Huala

Plant Biology

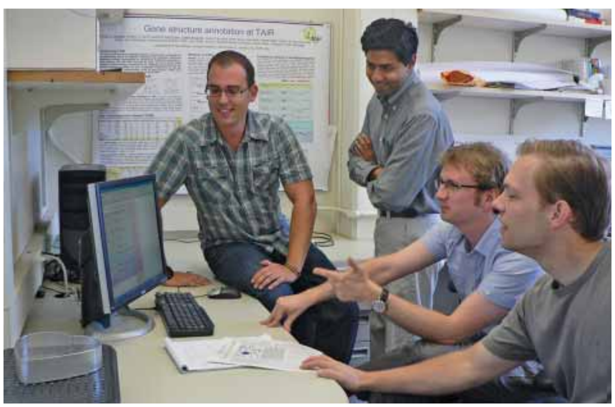


(Above) The genome annotation team's confidence ranking system (sample shown here) looks at each gene and evaluates the experimental support for its structure. The ranking reveals which *Arabidopsis* gene structures are reliable enough to serve as predictors of the gene structures in other plant genomes.

Image courtesy Eva Huala

(Below) Members of the TAIR team are viewing a confidence ranking chart. From left to right are Philippe Lamesch, Rajkumar Sasidharan, David Swarbreck, and Chris Wilks.

Image courtesy Eva Huala



Gatekeepers Get Their Due

With the explosion of information about genes and the proteins they make, it is remarkable that so little is known about how proteins interact with and within the protective membrane that surrounds a plant cell. These membrane proteins mediate acquisition of nutrients and water, secrete compounds and toxins, and, most importantly, sense aspects of their environment. They thus represent the communication interface of the cell to the outside world. They affect growth, development, and everything else. Now Sylvie Lalonde, Wolf Frommer, and a team of collaborators from UC San Diego, Penn State, and U. Maryland have attacked this information deficit head-on. As a pilot study these researchers used a high-throughput molecular screen and pinned down 900 interactions among 200 proteins out of 100,000 possible relations for the experimental plant *Arabidopsis*. They have another 3,500 genes in the pipeline to determine the complete

portfolio of interactions among membrane proteins and their partners inside the cell. Their work paves the way to a better understanding of plants and possibly to engineering them to thrive under drought or heat conditions, or otherwise to become more productive.

All of the inner workings of the cell rely on the binding of proteins. With complementary shapes, proteins dock with one another to start processes, such as telling a gene to turn on or letting in the proper nutrient. Membrane proteins make up some 20% of the proteins in *Arabidopsis*.

In the first step, the team targeted proteins that begin the communications process at the membrane to turn genes on in the nucleus. They used a screen called the mating-based protein complementation assay, or split ubiquitin system. Ubiquitin is a small protein. The scientists fused the candidate proteins onto a version of ubiquitin that is split in half. When the two candidates interact, the two halves of the ubiquitin reassemble, triggering a process that liberates a transcription factor—a protien that switches a gene on—which then goes to the nucleus. When genes are turned on in the nucleus, the researchers are alerted to the successful interaction.

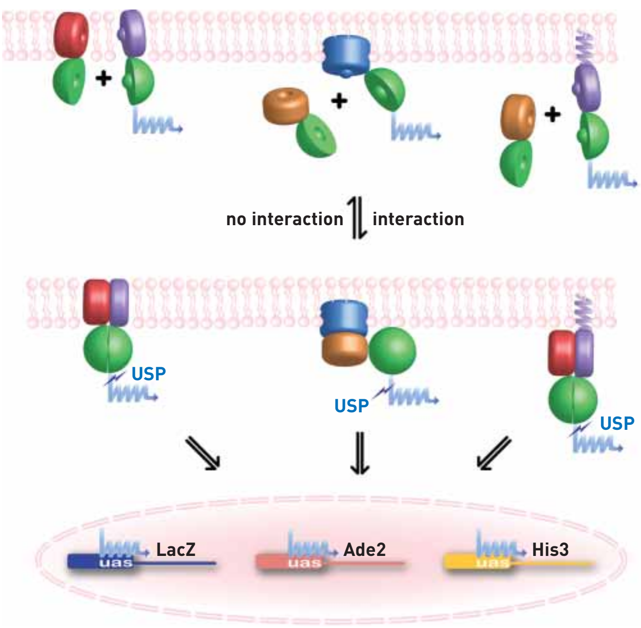
The scientists compiled a list of 8,358 candidate proteins based on information in the TAIR database, the literature, and predictive software. The ultimate goal is to test the 36 million potential interactions with a high-throughput robotics system.

This first-of-its-kind, high-throughput screen for *Arabidopsis* is just the beginning. As the library of interacting proteins grows, scientists will be able to study the details of protein interactions and how they are affected by outside forces, such as environmental changes. This project produced the first set of membrane protein interactions for any multicellular organism, and is thus relevant to crops and human medicine. □

(Above) Sam Parso and Maria Sardi are standing at the robot performing a screen.

(Below) This schematic shows what happens during three different scenarios of the screen called the mating-based protein complementation assay, or split ubiquitin system. In each case, when one protein (red or brown) interacts or docks with another (purple or blue), an ubiquitin protein is "reconstituted" (green sphere), releasing a transcription factor—a protien that switches a gene on (blue zigzag). The transcription factor then enters the nucleus of the cell (oval area), and turns genes on to alert researchers of the interaction.

Image reprinted with permission from Plant Journal 53, *610-635, 2008.*



Terrestrial Magnetism

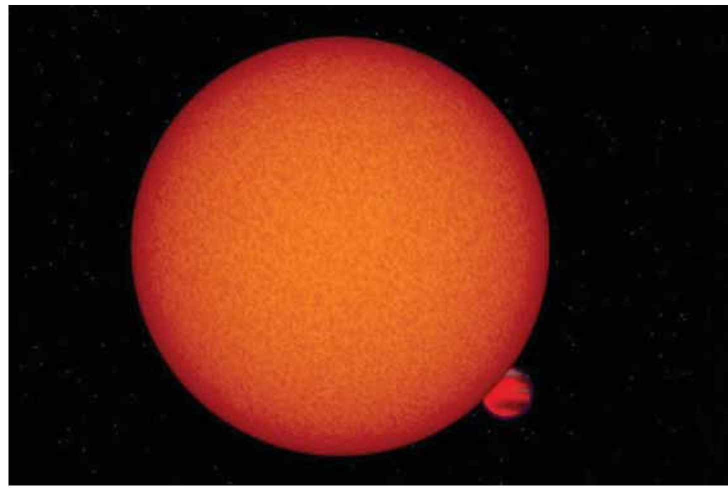
Understanding Earth, Other Planets, and Their Place in the Cosmos

A Hot Year for Exoplanets

One planet spins around its star, glowing like a kitchen burner. At over 4,400°F, OGLE-TR-56b has the hottest planetary atmosphere yet measured. Another planet, HD8606b, can be a relatively balmy 980°F, but within a few hours its eccentric orbit swings it close to its star, driving temperatures beyond 2,200°F.

Both of these extrasolar planets had their extraordinary temperatures measured by research teams that included scientists from the Department of Terrestrial Magnetism (DTM). OGLE-TR-56b is a "hot Jupiter" whose temperature was measured by Hubble Fellow Mercedes López-Morales with coauthor David Sing from Institut d'Astrophysique de Paris using over 600 images from the European Southern Observatory's Very Large Telescope and Carnegie's Magellan Baade telescope in Chile. The researchers needed the multiple images and near-ideal seeing conditions to measure accurately the change in thermal emissions when the planet was eclipsed as it went behind the star. Only about one of every 3,000 photons from the system comes from the planet. The eclipse allowed the researchers to separate the emissions of the planet from those of the star.

Along with a measurement of a different planet published simultaneously by an independent group, these were the first such measurements by ground-based instruments. Previously, all thermal emissions from extrasolar planets had been measured by NASA's Spitzer Space Telescope in Earth orbit. López-Morales notes that their ground-based temperature measurements mark an important achievement and provide a new way to continue studying exoplanet atmospheres. This is important because the work-horse Spitzer telescope has recently run out of the coolant that chills its infrared sensors, highly limiting its capabilities.

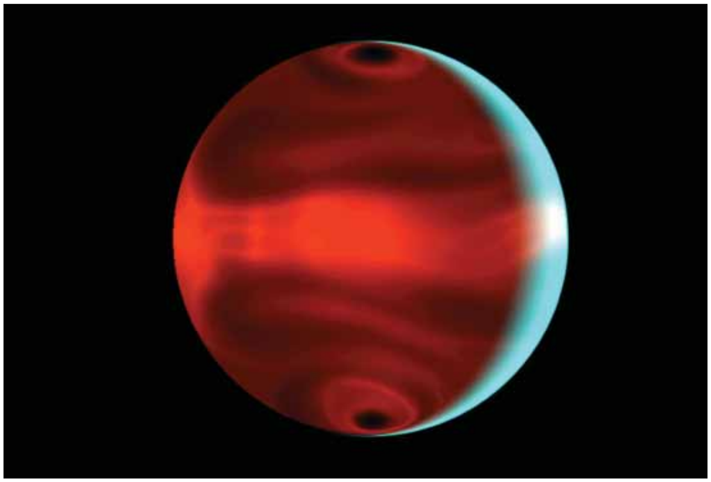


(Above) This artist's impression shows the exoplanet OGLE-TR-56b passing behind its star. At over 4400°F, the atmosphere of OGLE-TR-56b is the hottest yet observed for any exoplanet and is the first measured from ground-based instruments.

Image © D. Sing (IAP) / A&A.

(Right) Mercedes López-Morales

Image courtesy Mercedes López-Morales



(Above) The exoplanet HD8606B experiences extreme variations in temperature due to its highly eccentric orbit. This computer-generated image shows the severe weather patterns in its atmosphere during the days after its closest approach to its parent star.

Image courtesy Greg Laughlin, University of California, Santa Cruz

(Right) Paul Butler

Image courtesy Paul Butler

Paul Butler played a key role in discovering the spectacular temperature swings of HD8606b, which orbits a star 200 light-years from Earth. For this space-based study using the Spitzer Space Telescope, Butler made the precise velocity measurements of the host star, thereby enabling the planet's orbit to be calculated. As with the ground-based study, infrared observations had to be centered on the time that the planet passed behind the star, known as a secondary eclipse. The disappearance of the planet during the secondary eclipse allowed the measurements to be calibrated and the planet's temperature changes to be determined.

Both of these discoveries add to the growing store of knowledge about extrasolar planets. Butler, whose work with others has uncovered about half of the known extrasolar planets, commented, "Even after finding nearly 200 planets, the diversity and oddness of these new worlds continue to amaze and confound me."

Diamonds and Continental Geology

Diamonds form in the Earth's mantle, especially beneath the ancient, stable portions of continents called cratons. As a result, diamond prospectors have long followed Clifford's Rule: Look in the oldest parts of the craton. But DTM's Steven Shirey has found that the story is not so simple. Diamonds can have a complex history, intimately tied to the geologic evolution of continents.

Large diamonds act as inert capsules that can preserve ancient mantle minerals brought up from depths of more than 75 miles (120 kilometers) by younger volcanism. Working with visiting investigators and other colleagues over the last decade, Shirey has studied hundreds of iron sulfide inclusions in diamonds from across southern Africa. With techniques developed at DTM, he measured the ages of the inclusions using the rhenium-osmium dating system. Radioactive isotopes of rhenium decay to yield osmium at an extremely slow rate, making the system a good atomic clock to date ancient rocks and minerals. Shirey found that the inclusion age and distribution pattern document the assembly of the ancient Kaapvaal Craton by the collision of two continental blocks 2.9 billion years ago, as well as later tectonic activity at its margins extending as deep as 93 miles (150 km).

Where the two blocks came together is a fossil subduction zone that dips to the west. Shirey found that west of this zone the sulfide minerals in diamonds are most commonly 2.9 billion years old—the same age as the continental collision. East of the zone, inclusions of this age are largely missing and are younger by more than a billion years. This difference suggests a close tie between ancient subduction and diamonds: carbon-bearing fluids carried deep into or below the craton's keel by oceanic

Terrestrial Magnetism, *Continued*

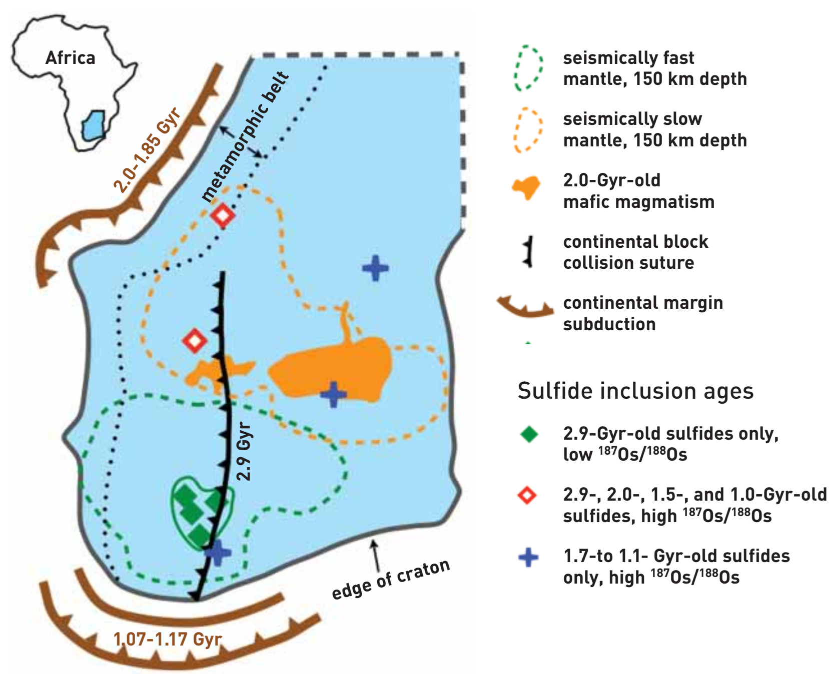
slabs percolated upward and crystallized diamonds only in that portion of the keel above the subducted slabs.

Younger diamonds were generated as the assembled craton was subjected to later subduction around its margins and to magmatism from below. These diamonds are found preferentially in areas close to past marginal subduction zones (evident today from belts of metamorphic rocks) and above areas of the mantle once invaded by magma (evident by the low velocity of seismic waves). In contrast, the 2.9-billion-year-old diamonds predominate above seismically "faster" mantle that had much less infiltration of magma. These diamond age patterns are providing the deepest new evidence yet on how continents were created and modified.

Earth's Oldest Crust

For some time, the oldest crust known on Earth was a 3.8-billion-year-old terrane in southern Greenland. In 1990, rocks from the Northwest Territories in Canada were found to be as old as 4.04 billion years. Just last year, DTM's Richard Carlson, with Ph.D. student Jonathan O'Neil, dated bedrock from northern Quebec at 4.28 billion years old, making it 250 million years older than any previously studied rocks.

These discoveries result from new geochronologic methods, similar to those pioneered at DTM in the 1950s, that allow accurate dating of rocks with long, complicated



(Above) Steven Shirey

(Right) Sketch map of the Kaapvaal-Zimbabwe Craton showing the position of key tectonic, magmatic, and mantle keel components in relation to the age and isotopic grouping of diamond inclusions. The craton's boundary is shown as a gray line (solid and dashed). The suture between its two halves is black with teeth. Relics of subduction zones around the craton's margin are shown as brown lines with teeth. Symbols show diamond mines that yielded samples for the study.

Images courtesy Steven Shirey

The point at Nuvvuagittuq, translated from Inuktitut as "point with white stripes," shows nearly 1.5 billion years of Earth history. The white rocks are 2.7 billion-year-old igneous rocks intruding older rocks, including remnants of ancient seafloor dated at 4.28 billion years by Rick Carlson and Jonathan O'Neil at DTM.
Image courtesy Rick Carlson

A film crew from the History Channel interviews DTM postdoc Jonathan O'Neil (second from right) at the field site in Nuvvuagittuq.
Image courtesy Rick Carlson

histories of heating and deformation. Carlson and O'Neil, now a postdoctoral fellow at DTM, obtained their dates by measuring minute variations in the isotopic composition of the rare Earth element neodymium in the rocks. In summer 2009 they returned to Nuvvuagittuq, as the Quebec terrane is named by the region's native Inuit, to continue exploring this small, 10-square-kilometer remnant of Earth's ancient crust.

The old Nuvvuagittuq rocks appear to represent a section of ancient seafloor, with magnesium-rich basalts similar to those found in modern oceanic crust. Some of the basalts also contain what Carlson and O'Neil interpret to be "pillow" structures that formed when hot lava cooled rapidly because of eruption under water. The terrane also includes extensive deposits of silica (now quartz) and iron oxide that likely formed as ocean water circulated through the hot rocks of newly formed oceanic crust.

Carlson and O'Neil's work on the Nuvvuagittuq rocks support conclusions from 4.36-billion-year-old mineral grains in Australia that imply that within 200 million to 300 million years of the Earth's formation its surface was already cold enough to harbor liquid water, and hence, oceans. The type of seafloor setting represented by the Nuvvuagittuq rocks today supports distinctive life forms that derive energy from chemicals in the environment, rather than from photosynthesis. Geophysical Laboratory postdoctoral fellow Dominic Papineau is among the scientists studying Nuvvuagittuq and similar sites for chemical markers of possible early life. Although definitive evidence has not yet been found, nor will it be easy to find because of the rocks' complicated metamorphic history, these ancient terranes provide new insights into Earth's earliest environments. □

First Light & The Carnegie Academy

Teaching the Art of Teaching Science

CASE Broadens Its Scope

Math for America

To help combat the disturbing international standing that American students have in science, technology, engineering, and mathematics, the Carnegie Academy for Science Education (CASE) started a new initiative in 2008. It launched a partnership with Math for America (M*f*A) and American University (AU) to create Math for America in Washington, D.C. (M*f*A DC). The goal is to improve the mathematics education of the city's public and public charter secondary school students. Bianca Abrams is the program director.

Many certified teachers in the U.S. are not trained in the specific subject they teach. Through a rigorous selection process, M*f*A DC chooses individuals with undergraduate degrees in mathematics or related disciplines to train them to become skilled mathematics teachers. Applicants must have strong undergraduate records in math and are evaluated based on undergraduate records, test scores, recommendations, personal statements, and interviews.

With stimulus funds from the American Recovery and Reinvestment Act of 2009, the National Science Foundation awarded M*f*A DC a $1.498 million grant to cover the tuition, stipend, and mentoring costs for the first 14 M*f*A Fellows. The first fellows arrived in the middle of June and finished one semester at AU, where they will spend a total of 15 months taking education and advanced math courses. They will then receive a master of arts in secondary school math teaching and be qualified for certification to teach in D.C. schools. Next summer, they will seek positions in D.C. public and charter secondary schools. In return for support, M*f*A Fellows agree to teach for four years in D.C. schools. The plan is to select and educate 34 fellows in total.

for Science Education

Biotech at Full Steam

Another 50 students graduated from McKinley Technology High School under the new D.C. Biotechnology Career Pathway Program, bringing the total of DCBiotech alumni to nearly 100. Biotechnology was also chosen by the principal of Ballou Senior High School as one of the three career-education pathways to retain as part of a redistribution of career-education options in D.C. high schools.

Ten students interned this summer at Howard University, Catholic University of America, Carnegie, and McKinley and Ballou high schools. The summer program at Ballou, cotaught by CASE codirector Julie Edmonds and CASE Teacher Fellow John Solano, was carried out in collaboration with Sarah Tishkoff's laboratory at the University of Pennsylvania. McKinley's summer program, led by coordinator of CASE programs Marlena L. Jones, employed several McKinley biotech alumni, who taught the students and shared their college experiences with them. □

(Left, top) Shown celebrating after their first semester at AU are MfA Fellows Katherine Collins, Molley Kaiyoorawongs, and Max Mikulec (left to right).

(Left, bottom) Lindsay Mann (left) and Krystn Hodge (right)

Images courtesy Bianca Abrams

McKinley students identify an unknown "infectious" microbe in a patient sample. Students work with real microbes, though not those that are actually infectious.

Image courtesy Toby Horn

Financial Profile

for the year ending June 30, 2009 (unaudited)

Reader's Note: ***In this section, we present summary financial information that is unaudited. Each year the Carnegie Institution, through the Audit Committee of its Board of Trustees, engages an independent auditor to express an opinion about the financial statements and the financial position of the institution. The complete audited financial statements are made available on the institution's website at www.CarnegieScience.edu.***

The Carnegie Institution of Washington experienced a challenging period financially during fiscal year 2009. Our endowment declined by approximately 27% in value during this period. This decline was consistent with the general trend in the financial markets and with the experience of other endowments at institutions of higher education and nonprofit organizations. Throughout the period, Carnegie held sufficient cash and bond funds to meet all ongoing operational requirements, debt obligations, and investment obligations, and avoided the need for any liquidation of investments and financial resources at otherwise unfavorable terms. Like most other institutions, Carnegie has tried to deal with this situation by restricting its budget, while simultaneously ensuring the continuation of a healthy scientific enterprise.

Carnegie has spent considerable time during the last year, under the supervision of the Board of Trustees, to ensure that our investments continue to provide the foundation for long-term growth. Even with the recent decline, the endowment's value over the last decade has grown from $478 million to approximately $663 million (as of September 9, 2009). As a result, over the period 2001-2009, average annual increases in endowment contributions to the budget were 6.6%. For 2009-2010, the endowment support for the budget will decline by 3.8%. Carnegie will continue to balance the requirement for stable support for current operations with preservation of capital to meet long-term needs.

In the near term, the hardship resulting from the endowment decline has been substantially alleviated by the availability of increased federal and foundation support. Carnegie's federal support has grown from $24.5 million in 2006 to $29.7 million in 2009. This is a testament to the high quality of Carnegie scientists and their ability to compete successfully for federal support. Funding from foundations has grown from an average of about $3.2 million per year in the period from 2000 to 2003 to about $5.6 million per year in 2007-2009.

Carnegie's long-term financial strength was reaffirmed this past year by Moody's Investors Service and Standard & Poor's. These rating agencies reviewed Carnegie's financial position and gave the institution their highest and second highest rankings, respectively, a level achieved by only a few nonprofit organizations. Carnegie's financial strength is based upon an investment strategy that seeks long-term positive returns from the diversified investments within its endowment; a disciplined spending policy that balances today's needs with the long-term requirements of the institution and the interests of future scientists; and the continued support of organizations and individuals who recognize the value of nurturing basic science.

Throughout its history, a primary source of support for the institution's activities is its endowment. This reliance on institutional funding provides an important degree of independence in the research activities of the institution's scientists. For a number of years, under the direction of the Finance committee of the board, Carnegie's endowment has been allocated among a broad spectrum of asset classes including fixed-income instruments (bonds), equities (stocks), absolute return investments; real estate partnerships; private equity; and natural resources partnerships. The goal of this diversified approach is to generate attractive overall performance and minimize the volatility that would exist in a less diversified portfolio.

The Finance committee of the board regularly examines the asset allocation of the endowment and readjusts the allocation, as appropriate. The institution relies upon external managers and partnerships to conduct the investment activities, and it employs a commercial bank to maintain custody. The following chart shows the allocation of the institution's endowment among the asset classes it uses as of June 30, 2009.

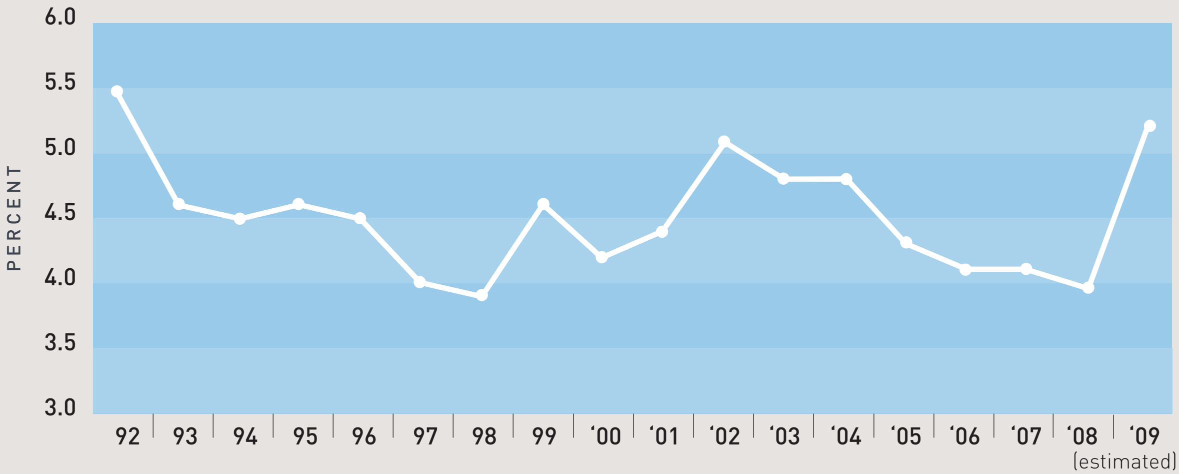
Asset Class	Target	Actual
Common Stock	35.0%	33.0%
Alternative Assets	55.0%	58.6%
Fixed Income and Cash	10.0%	8.4%

Carnegie's investment goals are to provide high levels of current support to the institution and to maintain the long-term spending power of its endowment.

Carnegie has also pursued a long-term policy of controlling its spending rate, bringing the budgeted rate down in a gradual fashion from 6+ percent in 1992 to 5.00% for 2009. Beginning with fiscal year 2008, Carnegie has revised its spending method from calculating the five percent against a simple three-year average of year-ending endowment values to a 70/30 rule, which factors in the previous year's spending. That is, the amounts available from the endowment under the 70/30 rule is made up of 70% of the previous year's budget, adjusted for inflation, and 30% of the most recently completed year-end endowment value, multiplied by the spending rate of 5.0% and adjusted for inflation and for debt. This method reduces volatility from year-to-year. The following figure depicts actual spending as a percentage of ending market value for the last 18 years.

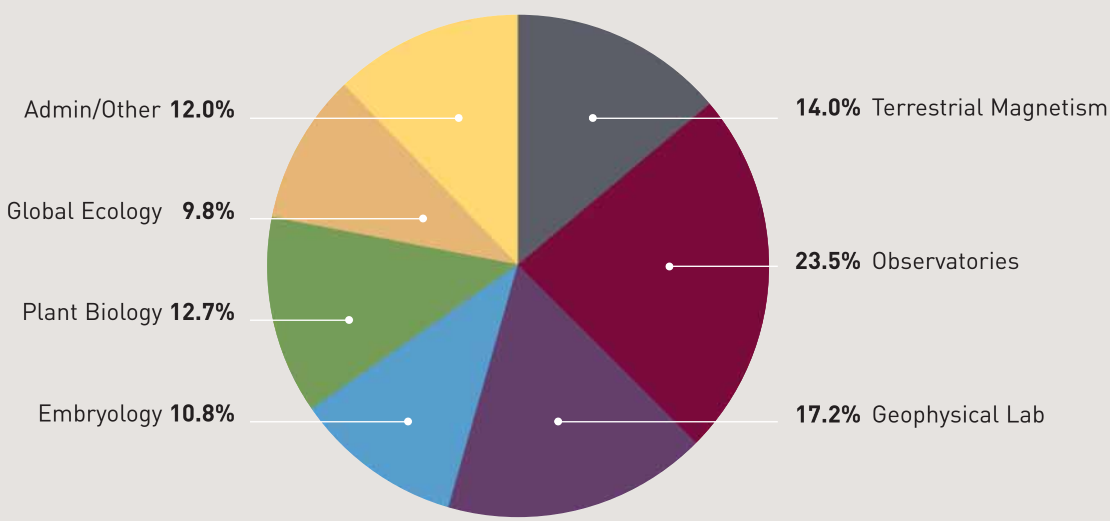
In addition to investment performance and spending restraint, Carnegie benefits from external support. Within Carnegie's endowment, there are a number of "funds" that provide support either in a general way or targeted to a specific purpose. The largest of these is the Andrew Carnegie Fund, begun with the original gift of $10 million. Mr. Carnegie later made additional gifts totaling another $12 million during his lifetime. This tradition of generous support for Carnegie's scientific mission has continued throughout our history, and a list of donors in fiscal year 2009 appears in an earlier section of this year book. In addition, Carnegie receives important federal and private grants for specific research purposes, including support from the Howard Hughes Medical Institute for researchers at the Department of Embryology.

Endowment Spending as a Percent of Ending Endowment Value*



*Includes debt financing

2009 Expenses by Department ($82.7 Million)



Statements of Financial Position (unaudited)

June 30, 2009 and 2008

	2009	2008
Assets		
Current assets:		
Cash and cash equivalents	3,587,777	957,861
Accrued investment income	46,430	138,050
Contributions receivable	5,519,038	6,885,460
Accounts receivable and other assets	16,750,719	6,474,614
Bond proceeds held by trustee	39	121,904
Total current assets	$ 25,904,003	$ 14,577,889
Noncurrent assets:		
Investments	633,525,475	895,939,989
Property and equipment, net	157,980,529	162,108,756
Total noncurrent assets	$791,506,003	$1,058,048,745
Total assets	$817,410,006	$1,072,626,634
Liabilities and Net Assets		
Accounts payable and accrued expenses	9,759,780	27,217,376
Deferred revenues	40,746,194	36,539,753
Bonds payable	65,358,062	65,303,339
Accrued postretirement benefits	14,560,478	14,486,199
Total liabilities	$130,424,514	$ 143,546,667
Net assets:		
Unrestricted	206,347,417	264,490,808
Temporarily restricted	425,774,379	609,844,386
Permanently restricted	54,863,696	54,744,773
Total net assets	$686,985,492	$ 929,079,967
Total liabilities and net assets	$ 817,410,006	$1,072,626,634

Statements of Activities[1] (unaudited)

Periods ended June 30, 2009 and 2008

	2009	2008
Revenue and support:		
Grants and contracts	$ 34,257,350	$ 33,051,740
Contributions, gifts	10,102,788	10,227,204
Net gain or (loss) on property disposal	—	(49,772)
Other income	31,966,105	(18,624,082)
Net external revenue	$ 76,326,242	$ 24,605,090
Investment income and unrealized gains (losses)	($236,535,117)	81,245,420
Total revenues, gains, other support	($160,208,875)	$105,850,510
Program and supporting services:		
Terrestrial Magnetism	11,584,642	11,635,917
Observatories	19,460,830	18,455,315
Geophysical Laboratory	14,202,009	14,125,190
Embryology	8,925,327	8,593,858
Plant Biology	10,506,356	10,518,171
Global Ecology	8,087,259	4,263,800
Other programs	1,273,575	661,776
Administration and general expenses	8,654,348	6,853,537
Total expenses	$ 82,694,346	$ 75,107,564
Pension Related Changes	808,745	631,205
Increase (decrease) in net assets	-242,903,220	30,742,946
Net assets at the beginning of the period	929,079,967	897,705,816
Net assets at the end of the period	$ 686,985,492	$929,079,967

[1]Includes restricted, temporarily restricted, and permanently restricted revenues, gains, and other support.

Personnel

July 1, 2008-June 30, 2009

Carnegie Administration

Benjamin Barbin, *Manager of Advancement Activities*
Sharon Bassin, *Assistant to the President/Assistant Secretary to the Board*[1]
Shaun Beavan, *Systems Administrator*
Gloria Brienza, *Budget and Management Analysis Manager*
Don Brooks, *Building Maintenance Specialist*
Marjorie Burger, *Financial Manager*
Cady Canapp, *Human Resources and Insurance Manager*
Alan Cutler, *Science Writer*
Robert Ellis, *Web Developer*
Michelle Fisher, *Events and Facilities Coordinator*[2]
Shawn Frazier, *Accounting Technician*
Dina Freydin, *Senior Grants Accountant*
Susanne Garvey, *Director of External Affairs*
Jason Gebhardt, *Advancement Researcher*
Darla Keefer, *Special Assistant for Administration and Building Operations*
Mulyono Kertajaya, *Business Data Analyst/Developer*
Ann Keyes, *Payroll Coordinator*
Yang Kim, *Deputy Financial Manager*
Lisa Klow, *Executive Assistant to the President*
George Gary Kowalczyk, *Director of Administration and Finance*
Tina McDowell, *Editor and Publications Officer*
Richard Meserve, *President*
June Napoco-Soriente, *Financial Accountant*
Mikhail Pimenov, *Endowment Manager*
Arnold Pryor, *Facilities Coordinator*
Gotthard Sághi-Szabó, *Chief Information Officer*
Vinutha Saunshimath, *Computer Systems Associate*[3]
Ashit Sheth, *Computer Systems Associate*[4]
Harminder Singh, *Financial Systems Accountant*
Henry Spencer, *Information Technology Intern*
John Strom, *Web Manager*
Mira Thompson, *Manager of Advancement Operations*
Kenneth Tossell, *Computer Systems Associate*[5]
Rohan Vanjara, *Web Developer Intern*[6]
Yulonda White, *Human Resources and Insurance Records Coordinator*
Jacqueline Williams, *Assistant to Human Resources and Insurance Manager*
Bryant Zadegan, *Web Developer Intern*[7]

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[1]To February 27, 2009
[2]From July 21, 2008
[3]To August 31, 2008
[4]To August 31, 2008
[5]To August 31, 2008
[6]From June 15, 2009
[7]From October 20, 2008

Carnegie Academy for Science Education

Bianca Abrams, *Director, Math for America*[1]
Faith Ajayi, *CASE Intern*[2]
Victor Akosile, *CASE Intern*[3]
Monica Artis, *CASE Intern*[4]
Suria Bahadue, *CASE Intern*[2]
Brenton Bassin, *CASE Intern*[5]
Sarah Bax, *CASE Mentor*[6]
Keisha Blackmoore, *CASE Intern*[3]
Brittney Bradley, *CASE Intern*[2]
Guy Brandenburg, *First Light Instructor and Mentor*
Anne Brooks-Hemphill, *CASE Mentor*[6]
DeMarcus Clark, *CASE Intern*[3]
Alexander Cole, *CASE Intern*[3]
Katherine Collins, *Math for America Fellow*[7]
Asonia Dorsey, *CASE Mentor*[6]
Vannessa Duckett, *CASE Mentor*[6]
Julie Edmonds, *Codirector CASE*
Ricky Garibay, *Intern and First Light Assistant*
Joseph Green, *CASE Intern*[3]
Rhia Hardman, *CASE Intern*[3]
Tashima Hawkins, *CASE Mentor*[6]
Gayan Hettipola, *CASE Intern*[8]
Krystn Hodge, *Math for America Fellow*[7]
Toby M. Horn, *Codirector, CASE*
Safiya Howard, *CASE Intern*[3]
Trisha Ibeh, *CASE Intern*[2]
Joseph Isaac, *CASE Fellow*
Marlena Jones, *DC Biotech Coordinator*
Molley Kaiyoorowongs, *Math for America Fellow*[7]
Loretta Kelly, *CASE Mentor*[6]
M'Heeraw Kennedy, *CASE Intern*[9]
Yeelan Ku, *CASE Intern*[10]
Elishauntae Lindsay, *CASE Intern*[3]
Lindsay Mann, *Math for America Fellow*[7]
Michael McCreary, *CASE Intern*[3]
My'Chelle McCreary, *CASE Intern*[2]
Sunday McIlwain, *CASE Intern*[3]
Max Mikulec, *Math for America Fellow*[7]
Thomas Nassif, *CASE Mentor*[6]
Stephanie Navarrette, *CASE Intern*[11]
Yolande Paho, *CASE Intern*[11]
Debron Rodney, *CASE Intern*[11]
Marciel Rosario-Rojas, *CASE Intern*[3]
Brittney Sims, *CASE Intern*[11]
John Solano, *CASE Fellow*[11]
Liza Styles, *Math for America Fellow*[7]
John Tatum, *CASE Mentor*[6]
Kelechi Ukaegbu, *CASE Intern*[3]
Juna Wallace, *Intern and First Light Assistant*[11]
Isaiah West, *CASE Intern*[11]

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[1]From August 4, 2008
[2]From June 22, 2009
[3]To August 31, 2008
[4]To June 30, 2009
[5]To August 8, 2008
[6]To August 15 2008
[7]From April 29, 2009
[8]From May 26, 2008
[9]From June 29, 2009
[10]To May 30, 2009
[11]To August 31, 2009

EMBRYOLOGY Front Row (left to right): Allan Spradling, Donald Brown, Joseph Gall, Marnie Halpern, Alex Bortvin, Steven Farber. Second row: Connie Jewel, Zehra Nizami, Mary Goll, Pat Cammon, Glenese Johnson, Ellen Cammon. Third row: Rosa Miyares, David MacPherson, Ami Patel, Rong Chen, Courtney Akitake, Margaret Hoang, Anying Zhang. Fourth row: Brian Hollenback, Stephen Heitzer, Sandrine Biau, Shreyas Jadhav, Jianjun Sun, Dianne Williams, Lamia Wahba, Rejeanne Juste. Fifth row: Dolly Chin, William Yarosh, Laura Pinder, Tagide deCarvalho, Eugenia Dikovskaia, Rafael Villagaray, Pedram Nozari, Freddie Jackson. Sixth row: Allison Pinder, Safia Malki, Ona Martin, Lei Lei, Katherine Mitchell, Svetlana Deryusheva, Fred Tan, Zheng-An Wu. Seventh row: Alan Rupp, Sang Jung Ahn, Vicki Losick, Alexis Marianes, C. Evan Siple, Pete Lopez, Daniel Escobar, Kate Lannon, Michelle Macurak. Eighth row: Judith Yanowitz, Pavol Genzor, Arash Adeli, Youngjo Kim, Megan Kutzer, Carol Davnport, Don Fox, Itay Onn, Dean Calahan, Vinny Guacci, Josh Bembenek. Back row: Christine Pratt, Junling Jia, Earl Potts, Robert Levis, Tom McDonaugh, Daniel Gorelick, Andrew Skora, Godfried Van der Heijden, James Walters, Cheng Xu, Ben Goodman.

Embryology

Research Staff Members

Alexsky Bortvin
Donald D. Brown, *Director Emeritus*
Chen-Ming Fan
Steven Farber
Joseph G. Gall
Marnie Halpern
Douglas E. Koshland
Allan C. Spradling, *Director*
Yixian Zheng

Staff Associates

Jeffrey Han
David MacPherson
Judith Yanowitz

Postdoctoral Fellows and Associates

Sang Jung Ahn, *Research Associate, NIH Grant (Halpern)*[1]
Joshua Bembenek, *Howard Hughes Medical Institute Research Associate*[2]
Sandrine Biau, *Carnegie Fellow*
Rachel Cox, *Howard Hughes Medical Institute Research Specialist*[3]
Tagide deCarvalho, *Research Associate, NIH Grant (Halpern)*[4]
Svetlana Deryusheva, *Visiting Scientist, Carnegie*
Lucilla Facchin, *Eppley Foundation Grant (Halpern) and Carnegie Fellow*
Donald Fox, *Jane Coffin Childs Fellowship*
Rebecca Frederick, *American Cancer Society Fellowship*
Julie Gleason, *Research Associate, NIH Grant (Farber with Mayo Clinic, subcontract)*[5]
Mary Goll, *Damon Runyon Cancer Research Fellowship*
Daniel Gorelick, *Carnegie Fellow*
Vinny Guacci, *Howard Hughes Medical Institute Research Specialist*
Kotaro Hama, *Japan Foundation Fellowship*[6]
Shreyas Jadhav, *Carnegie Fellow*[7]
Junling Jia, *Howard Hughes Medical Institute Research Associate*[8]
Youngjo Kim, *Howard Hughes Medical Institute Research Associate*
Yung-Shu Kuan, *Carnegie Fellow*[9]
Lei Lei, *Howard Hughes Medical Institute Research Associate*[10]
Robert Levis, *Special Investigator, NIH Grant (Spradling with Baylor College of Medicine, subcontract)*
Zhonghua Liu, *Howard Hughes Medical Institute Research Associate*
Vicki Losick, *Howard Hughes Medical Institute Research Associate*[11]
Safia Malki, *Carnegie Fellow*
Lucy Morris, *Howard Hughes Medical Institute Research Associate*
Sandeep Mukhi, *NIH Grant (Brown)*
Todd Nystul, *Howard Hughes Medical Institute Research Associate*
Itay Onn, *Howard Hughes Medical Institute Research Associate*
Jianjun Sun, *Howard Hughes Medical Institute Research Associate*[12]
Frederick Tan, *Howard Hughes Medical Institute Research Associate*[13]
Tina Tootle, *Ruth Kirschstein (NRSA) Fellowship*
Godfried Van der Heijden, *Carnegie Fellow*
Queenie Vong, *Howard Hughes Medical Institute Research Associate*[14]
Cynthia Wagner, *Special Investigator, Carnegie Fellow*[15]
James Walters, *American Cancer Society Fellow*
Shusheng Wang, *Research Associate, NIH Grant (Zheng)*
Zheng-an Wu, *Special Investigator, NIH Grant (Gall) and Carnegie Fellow*
Cheng Xu, *Carnegie Fellow and NIH Grant (Fan)*

Predoctoral Fellows and Associates

Courtney Akitake, *The Johns Hopkins University*
Dean Calahan, *The Johns Hopkins University*
Juliana Carten, *The Johns Hopkins University*
Julio Castaneda, *The Johns Hopkins University*
Daniel Ducat, *The Johns Hopkins University*[16]
Pavol Genzor, *The Johns Hopkins University*[17]
Ben Goodman, *The Johns Hopkins University*
Jill Heidinger, *The Johns Hopkins University*
Margaret Hoang, *The Johns Hopkins University*
Kate Lannon, *The Johns Hopkins University*
Christoph Lepper, *The Johns Hopkins University*
Daniel Lighthouse, *The Johns Hopkins University*[18]
Peter Lopez, *The Johns Hopkins University*
Alexis Marianis, *The Johns Hopkins University*[19]
David Martinelli, *The Johns Hopkins University*
Vanessa Matos-Cruz, *The Johns Hopkins University*
Katie McDole, *The Johns Hopkins University*
Katherine Mitchell (formerly Lewis), *The Johns Hopkins University*
Rosa Miyares, *The Johns Hopkins University*[20]
Tim Mulligan, *The Johns Hopkins University*
Zehra Nizami, *The Johns Hopkins University*
Lori Orosco, *The Johns Hopkins University*
Andrew Skora, *The Johns Hopkins University*
Lamia Wahba, *The Johns Hopkins University*
Aaron Welch, *The Johns Hopkins University*

Supporting Staff

Arash Adeli, *Animal Technician*[21]
Jen Anderson, *Research Technician*
Susan Artes, *Carnegie Science Outreach Coordinator*[22]
Matthew Atkins, *Animal Technician*[23]
Ethan Bennett, *Student Assistant*[24]
Keisha Breland, *Animal Technician*[25]
Molly Broache, *Research Undergraduate*
James Bronson, *Research Undergraduate*[26]
Valerie Butler, *Animal Technician*[27]
Ellen Cammon, *Howard Hughes Medical Institute Research Technician I*
Patricia Cammon, *Howard Hughes Medical Institute Laboratory Helper*
Eric Chen, *Research Undergraduate*[28]
Richard Chen, *Research Undergraduate*
Rong Chen, *Howard Hughes Medical Institute Research Technician I*
Dolly Chin, *Administrative Assistant*
Katie Cole, *Student Assistant*
Karina Conkrite, *Research Technician*
Vanessa Damm, *Howard Hughes Medical Institute Laboratory Assistant*
Carol Davenport, *Howard Hughes Medical Institute Research Technician III*
Bianca Dennis, *Student Assistant*[29]
Neha Deshpande, *Research Undergraduate*[30]
Eugenia Dikovskaia, *Animal Facility Manager*
Chun Dong, *Research Scientist*
Jesse Dong, *Student Assistant*[31]
Andrew Eifert, *Assistant Facility Manager*
Zehra Eifert, *Animal Technician*[32]
Daniel Escobar, *Research Undergraduate*[33]
Lea Fortuno, *Animal Care Technician*
Ariela Friedman, *Student Assistant*[34]
Nicole Gabriel, *Animal Care Technician*
Tamar Harel, *Student Assistant*[35]
Fraser Heinis, *Student Assistant*[36]
Steven Heitzer, *Animal Technician*
Brian Hollenback, *Animal Technician*
Colin Huck, *Animal Technician*[37]
Ella Jackson, *Howard Hughes Medical Institute Laboratory Helper*
Fred Jackson, *P/T Animal Care Technician*
Connie Jewell, *Systems Administrator*
Glenese Johnson, *Laboratory Helper*
Rejeanne Juste, *Research Technician*
Susan Kern, *Business Manager*
Amy Kowalski, *Research Technician*
Bill Kupiec, *Information Systems Manager*
Megan Kutzer, *Technician*
David Lai, *Student Assistant, Ingenuity Program*[38]
Jaclyn Lim, *Student Assistant*[39]
Jonthan Liu, *Student Volunteer*[40]
Michelle Macurak, *Research Technician*
Sneha Mani, *Research Undergraduate*
Ona Martin, *Howard Hughes Medical Institute Research Technician III*
Tom McDonaugh, *Facilities Manager*
Khadijah McGhee-Bey, *Student Assistant*[41]
Wendy McKoy, *Administrative Assistant*
Pedram Nozari, *Animal Technician*[42]
Shelley Paterno, *Howard Hughes Medical Institute Research Technician II*[43]
Allison Pinder, *Howard Hughes Medical Institute Research Technician III*
Laura Pinder, *Student Assistant*[44]
Earl Potts, *Animal Technicia*
Christine Pratt, *Howard Hughes Medical Institute Administrative Assistant II*
Joan Pulupa, *Student Assistant*
Tosa Puvapiromquan, *Fly Food Technician*[45]
Megan Reid, *Student Assistant, Ingenuity Program*[46]
Victoria Robinson, *Student Assistant*[47]
Lissa Rotundo, *Special Investigator*[48]
Michael Sepanski, *Electron Microscopy Technician*
Mahmud Siddiqi, *Research Specialist*
Desiree Simpson, *Research Undergraduate*[49]
Alison Singer, *Research Technician*
C. Evan Siple, *Research Technician*
Ina Soh, *Research Undergraduate*[50]
Jessica Steele, *Carnegie Science Outreach Coordinator*[51]
Loretta Steffy, *Accounting Assistant*
Allen Strause, *Machinist*
Maggie Sundby, *Research Technician*
Robert Vary, *Carnegie Science Outreach Educator*[52]
Rafael Villagaray, *Computer Technician*
Neil Vranis, *Student Assistant*[53]
Dianne Williams, *Howard Hughes Medical Institute Research Technician III*
Alex Yeh, *Student Assistant*[54]
Geoffrey Zearfoss, *Animal Technician*[55]
Anying Zhang, *Visiting Scientist*[56]

Visiting Investigators and Collaborators

Joel Bader, *Department of Biomedical Engineering, The Johns Hopkins University*
Robert Baker, *Department of Physiology and Neuroscience, New York University School of Medicine*
James Beck, *Department of Physiology and Neuroscience, New York University School of Medicine*
Hugo Bellen, *Baylor College of Medicine*
Ian Blair, *Department of Chemistry, University of Pennsylvania*
Charles Boone, *University of Toronto, Canada*
Dana Carroll, *Department of Biochemistry, University of Utah*
Rosalind Coleman, *Department of Nutrition, University of North Carolina*
Michael Dean, *Laboratory of Genomic Diversity, NCI-Frederick*
Maitreya Dunham, *Carl Icahn Laboratory, Princeton University*
Steven Ekker, *Department of Genetics, Cell Biology and Development, University of Minnesota Medical School*
Michael Granato, *Department of Cell and Developmental Biology, University of Pennsylvania School of Medicine*
David Gresham, *New York University*
Matthias Hammerschmidt, *Max Planck Institute for Immunobiology, Germany*
Marko Horb, *Institut de Recherches Cliniques de Montréal (IRCM)*
Roger Hoskins, *Lawrence Berkeley National Laboratory*
Yiannis Ioannou, *Department of Genetics and Genomic Sciences, Department of Gene and Cell Medicine, Mount Sinai School of Medicine*
Gary Karpen, *Lawrence Berkeley National Laboratory*

Henry Krause, *Donnelly Centre for Cellular and Biomolecular Research, University of Toronto, Canada*
Peter Kwiterovich, *Department of Pediatrics, The Johns Hopkins University*
Steven Leach, *Department of Surgery, Division of Surgical Oncology, The Johns Hopkins University School of Medicine*
Li Ma, *Laboratory of Molecular Cell Biology and Center of Cell Signaling, Shanghai Institute for Biological Sciences, Chinese Academy of Sciences*
Cecilia Moens, *Fred Hutchinson Cancer Research Center*
Mari Moren, *National Institute of Nutrition and Seafood Research, Norway*
Karen Oogema, *European Molecular Biology Laboratory, Germany*
Michael Parsons, *Departments of Surgery and Oncology, The Johns Hopkins University School of Medicine*
Erez Raz, *Department of Germ Cell Development, Max Planck Institute for Biophysical Chemistry, Germany*
Gerald M. Rubin, *Howard Hughes Medical Institute, Janelia Farm Research Campus*
Bernard Thisse, *Department of Cell Biology and the Morphogenesis and Regenerative Medicine Institute, University of Virginia*
Christine Thisse, *Department of Cell Biology and the Morphogenesis and Regenerative Medicine Institute, University of Virginia*
Milena Vuica, *Department of Pathology, The Johns Hopkins University School of Medicine*

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[1]From November 1, 2008
[2]From October 1, 2008
[3]To October 1, 2008
[4]From June 1, 2009
[5]To May 1, 2009
[6]To November 30, 2008
[7]From April 24, 2009
[8]From October 1, 2008
[9]To August 31, 2008
[10]From June 1, 2009
[11]From September 15, 2008
[12]From September 1, 2008
[13]From August 18, 2008
[14]To October 31, 2008
[15]To June 15, 2009
[16]To May 21, 2009
[17]To May 21, 2009
[18]To July 15, 2008
[19]From June 1, 2009
[20]From September 1, 2006 (not listed previously)
[21]From January 12, 2009
[22]From July 23, 2008
[23]From June 8, 2009
[24]From June 15, 2009
[25]From August 4, 2008
[26]To December 31, 2008
[27]From May 22, 2009
[28]From January 29, 2009
[29]To August 15, 2008
[30]To August 15, 2008
[31]To August 15, 2008
[32]To January 15, 2009
[33]From September 3, 2008
[34]To August 31, 2008
[35]From May 26, 2009
[36]To May 21, 2009
[37]To September 30, 2008
[38]To June 30, 2008
[39]To August 31, 2008
[40]To May 21, 2009
[41]To August 15, 2008
[42]From May 13, 2009
[43]To January 30, 2009
[44]From June 15, 2009
[45]To July 31, 2008
[46]To August 31, 2008
[47]From May 27, 2009
[48]From June 15, 2009
[49]From September 12, 2008
[50]To April 30, 2009
[51]To November 15, 2008
[52]From August 11, 2008
[53]From May 28, 2009
[54]From June 9, 2009
[55]From December 21, 2008
[56]From December 8, 2008

Geophysical Laboratory

Staff Scientists

George D. Cody
Ronald E. Cohen
Yingwei Fei
Marilyn L. Fogel
Alexander F. Goncharov
Robert M. Hazen
Russell J. Hemley, *Director*
Wesley T. Huntress, Jr., *Director Emeritus*
T. Neil Irvine, *Emeritus*
Ho-kwang Mao
Bjørn O. Mysen
Douglas Rumble III
Andrew Steele
Viktor V. Struzhkin

Senior Research Fellows

Dudley R. Herschbach, *Harvard University*
Dimitri A. Sverjensky, *The Johns Hopkins University*
Takamitsu Yamanaka, *Osaka University, Japan*

Research Scientists

Muhetaer Aihaiti, *ONR*
Nabil Z. Boctor, *NASA, NASA Astrobiology Institute (NAI)*
Xiao-Jia Chen, *DOE*[1]
Dionysis I. Foustoukos, *NSF*[2]
Qi Liang, *CVD Diamond*
Anurag Sharma, *Shell Oil*
Maddury Somayazulu, *CDAC*
Chih Shiue Yan, *CVD Diamond, NSF, Carnegie*
Chang-Sheng Zha, *CDAC*

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Fang Peng, *Visiting Scholar, HPSynC*[8]
Eric Rod, *Beamline Technician, HPCAT*
Olga Shebanova, *Postdoctoral Research Associate, HPCAT*
Guoyin Shen, *Project Manager, HPCAT and HPSynC*

GEOPHYSICAL LABORATORY First row (left to right): Yingwei Fei, Ho-kwang (Dave) Mao, Bjørn Mysen, George Cody, Ronald Cohen, Robert Hazen, Russell Hemley, Douglas Rumble, Anat Shahar, Alexander Goncharov, Thomas (Neil) Irvine. Second row: Danielle Appleby, Pedro Roa, Verena Starke, Dina Bower, Lauren Cryan, Pamela Woodard, Qi Liang, Jinfu Shu, Susana Mysen, Takamitsu Yamanaka, Subramanian Natarajan, Adelio, Javier Montoya, Weifu Guo, Namhey Lee, Yoko Kebukawa, Allen Dalton, Bobbie Brown, Stephen Hodge. Third row: Constance Bertka, Garret Huntress, Kateryna Klochko, Mihaela Glamoclija, Dionysis Foustoukos, John Armstrong, Szczesny Krasnicki, Dyanne Furtado, Luke Shulenburger, Jeff Lightfield, Shaun Hardy, Trong Nguyen, Gefei Qian, Hannah Moore, Merri Wolf, Bill Key, Gary Bors, Scott Price, Stephen Gramsch, Julius Ojwang'. Back row: Yufei Meng, Qing Peng, Panchapakesan Ganesh, Shohei Ohara, Marilyn Venzon, Fabian Moscoso, Roxane Bowden, Maceo Bacote, Li Zhang, Morgan Phillips, Agnes Mao, Joseph Lai, Atsushi Kyono, Timothy Strobel, Henderson (Jim) Cleaves II.

Jinfu Shu, *Research Technician, HPCAT*
Stanislav Sinogeikin, *Beamline Scientist, HPCAT*
Lin Wang, *Balzan Fellow, Postdoctoral Researcher, HPCAT and HPSynC*
Yuming Xiao, *Postdoctoral Research Associate, HPCAT*
Wenge Yang, *Beamline Scientist, HPCAT*
Qiaoshi Charles Zeng, *Predoctoral Research Associate, HPSynC*[9]

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Dionysis I. Foustoukos, *Carnegie Fellow*[12]
Panchapakesan Ganesh, *Postdoctoral Associate*
Mihaela Glamoclija, *Carnegie Fellow*
Weifu Guo, *Carnegie Fellow*[13]
John Janik, *Carnegie Fellow, CDAC*[14]
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Caroline Jonsson, *Postdoctoral Associate, NASA*[16]
Yoko Kebukawa, *Carnegie Fellow, NAI*[17]
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Adrienne Kish, *Postdoctoral Associate, NASA and Keck Foundation*
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Takahiro Kuribayashi, *JSPS Fellow, Japan*[19]
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Xuan Luo, *Postdoctoral Associate, NSF*
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Yufei Meng, *Postdoctoral Associate*
Javier Antonio Montoya Martinez, *Carnegie Fellow*
Subramanian Natarajan, *Postdoctoral Associate, DOE*
Seth D. Newsome, *Postdoctoral Associate, NSF*[22]
Shohei Ohara, *Postdoctoral Associate, NSF*[23]
Julius Ojwang, *Postdoctoral Associate, NSF*[24]
Dominic Papineau, *Carnegie Fellow, NSF*[25]
Angèle Ricolleau, *Carnegie Fellow, NSF*
Anat Shahar, *Carnegie Fellow*[26]
Luke Shulenburger, *Postdoctoral Associate, NSF*[27]
Tim Strobel, *Carnegie Fellow, NSF*[28]
Ravindran Thoguluva, *Postdoctoral Associate, DOE*[29]
Michelle B. Weinberger, *Postdoctoral Associate, DOE*[30]
Li Zhang, *Postdoctoral Associate, NASA*

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Clare Flynn, *Predoctoral Fellow, NSF-NASA*[32]
Patrick L. Griffin, *NAI, Balzan Foundation Fund, Prewitt-Hazen Gift Fund*
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Yao Wu, *Predoctoral Research Associate, Chinese Education Ministry*[34]
Hong Yang, *Predoctoral Research Associate, NSF*[35]
Shidan Yu, *Predoctoral Research Associate, China Scholarship Council*[36]
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Celine Silver, *Emory University, Smithsonian funding*[40]
Emily Snyder, *American University, DTM NAI funding*[41]
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Justine Hart, *University of Iowa*
Mickey Kopstein, *College of William and Mary*
Zhili Liang, *Lehigh University*
Karina Marshall-Bowman, *University of Vermont*
Brendan O'Connor, *Montgomery College*
Adrianna Rajkumar, *Appalachian State University*
Rebecca Rattray, *Vanderbilt University*
Alexander Savello, *Emory University*
Angela Schad, *University of Notre Dame*
Allison Wende, *State University of New York, Oswego*

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Thomas Gramsch, *Lake Braddock High School*
Winston Liu, *Montgomery Blair High School*
Jackie Rivera, *Cesar Chavez High School*
Emily Sandford, *Glenelg Country School*
Benjamin Shih, *Montgomery Blair High School*
Nicholas Smith-Herman, *Sidwell Friends School*

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Gary A. Bors, *Building Engineer*[45]
Bobbie L. Brown, *Instrument Maker*
Stephen D. Coley, Sr., *Instrument Shop Supervisor*
Roy R. Dingus, *Facility Manager*[46]
Pablo D. Esparza, *Maintenance Technician*[47]
Dyanne Furtado, *Staff Accountant*[48]
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Shaun J. Hardy, *Librarian*[49]
Stephen Hodge, *Instrument Maker*
Garret Huntress, *Systems Administrator, Systems Developer*
Lauren Kerr, *Research Technician, Charles River Grant*
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Joseph Lai, *Laboratory Manager/Engineer*
Jeff Lightfield, *Controller*
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Eugene Zhao, *Electronics Engineer*[59]

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Pavel Zinin, *University of Hawai'i, HPCAT*

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[1]From August 1, 2007 (unintentionally omitted last year)
[2]From June 1, 2009
[3]From December 1, 2008
[4]From January 1, 2009
[5]To January 31, 2009
[6]From July 24, 1998 (unintentionally omitted in previous years)
[7]From June 1, 2009
[8]To July 31, 2008
[9]To December 31, 2008
[10]From January 1, 2009
[11]To June 30, 2009
[12]To May 31, 2009
[13]From October 24, 2008
[14]From September 3, 2008
[15]To December 12, 2008
[16]From June 1, 2009
[17]From June 9, 2009
[18]To September 23, 2008
[19]To July 30, 2008
[20]To December 5, 2008
[21]From January 26, 2009
[22]To June 15, 2009
[23]From November 17, 2008
[24]From February 17, 2009
[25]To March 31, 2009; postdoctoral associate from April 1, 2009
[26]From October 2, 2008, to June 30, 2009
[27]From July 7, 2008
[28]From September 22, 2008
[29]To November 28, 2008
[30]To March 4, 2009
[31]From June 1, 2009
[32]From June 1, 2009
[33]From June 1, 2009
[34]From December 1, 2007, to November 26, 2008 (unintentionally omitted last year)
[35]To March 3, 2009
[36]To December 29, 2008
[37]To August 5, 2008
[38]From June 3, 2009
[39]To December 31, 2008
[40]To August 31, 2008
[41]To August 31, 2008
[42]To August 8, 2008
[43]From September 2, 2008
[44]Joint appointment with DTM
[45]Joint appointment with DTM
[46]Joint appointment with DTM
[47]Joint appointment with DTM
[48]From June 16, 2009
[49]Joint appointment with DTM
[50]Joint appointment with DTM
[51]Joint appointment with DTM
[52]From June 24, 2008, to June 30, 2009
[53]From May 20, 2009
[54]From September 1, 2008
[55]Joint appointment with DTM
[56]From April 15, 2009, to June 15, 2009
[57]From August 18, 2008, to December 23, 2008
[58]Joint appointment with DTM
[59]To September 5, 2008
[60]Joint appointment with DTM

Global Ecology

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Mokila Joaquin, *Laboratory Technician*[32]
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Linda Longoria, *Administrative Assistant*
Reid Loo, *Laboratory Technician*[34]
Marion O'Leary, *Senior Advancement Consultant*[35]
Guayana Paez-Acosta, *Program Coordinator*[36]
Todd Tobeck, *Laboratory Coordinator*
Angela Torney, *Laboratory Assistant*
C. Parker Weiss, *Laboratory Technician*[37]

———

GLOBAL ECOLOGY **Above, front row: Matt Colgan, Guayana Paez-Acosta, Robin Martin, Linda Longoria, James Jacobson, Angelica Valdez, Jan Brown, Carey Lambrecht, Ken Caldeira. Middle row: Devon Arscott, Ruth Emerson, John Clark, Bill Anderegg, Alex Nees, Evana Lee, Susan Cortinas, Dahlia Wist, Turkan Eke, Mona Houcheime, Ismael Villa, George Ban-Weiss. Back row: Chris Field, Greg Asner, Marion O'Leary, Hannes Feilhauer, Jennifer Johnson, Chris Anderson, Aravindh Balaji, Parker Weiss, William Hu, Scott Loarie, David Knapp, Adam Wolf, Shaun Levick, Glenn Ford, Larry Giles, Joe Berry, Kris Ebi, Jim Kellner, Mike Mastrandrea, Paul Sterbentz. Small inset (left to right): Long Cao, Ho-Jeong Shin, Kenny Schneider. Bottom inset, front row (left to right): Lorelí Jiménez, Dina Cancino, Paola Martinez, Robin Martin, Lady Saldaña, Giannina Babilonia, Jazmin Teagua, Sara Del Castillo, Flor Panduro. Top row: Felip Cansino, Juan Vega, Raúl Trujillo, James Rodriguez, Julio Ccoycosi, Gabriel Sangama, Abner Fachin, Nestor Jarama, Greg Asner.**

[1]To August 15, 2008
[2]From September 15, 2008
[3]From October 1, 2008
[4]From September 16, 2008
[5]To August 31, 2008
[6]To August 29, 2008
[7]From September 24, 2008
[8]To March 31, 2009
[9]From November 17, 2008
[10]From March 16, 2009
[11]From August 1, 2008
[12]From March 1, 2009
[13]To August 31, 2008
[14]To June 15, 2009
[15]From March 1, 2009
[16]From September 1, 2008
[17]To June 15, 2009
[18]From September 15, 2008
[19]From September 2, 2008, to March 6, 2009
[20]From April 13, 2009
[21]From June 6, 2009
[22]From January 5, 2009
[23]From June 6, 2009
[24]From December 23, 2008
[25]From November 1, 2008, to February 28, 2009
[26]From April 1, 2009
[27]From June 6, 2009
[28]From August 15, 2008
[29]From October 15, 2008
[30]From December 12, 2008, to April 27, 2009
[31]From April 1, 2009
[32]From April 1, 2009
[33]From September 15, 2008
[34]From April 1, 2009
[35]From January 7, 2008
[36]From December 1, 2008
[37]From January 12, 2009

THE OBSERVATORIES First row (left to right): Jenna Ryon, Lea Zernow, Becky Lynn, Jorge Estrada, Luis Ho, Gus Oemler, Silvia Hutchison, Wendy Freedman, Ken Clardy, Robert Storts, Janice Lee, Matt Johns, Amnon Talmor, Lei Bai, Jane Rigby, Laura Sturch. Second row: Dan Kelson, Alan Uomoto, Greg Ortiz, Violet Mager, Vgee Ramiah, Gillian Tong, Ayako Jinno-Kanayama, Arnold Phifer, Sharon Kelly, Eric Persson, John Grula, Pat McCarthy, Christoph Birk, Mark Seibert, François Schweizer, Joshua Simon, Masami Ouchi, Alan Bagish, Eli Slawson, Ivelina Momcheva. Third row: Scott Rubel, George Preston, Steve Wilson, Luis Ochoa, Edward Villanueva, Arthur Eigenbrot, Cameron Charness, Magnus Haw, Andrew Monson, Jeff Crane, John Mulchaey, Charlie Hull, Earl Harris, Barry Madore, Rob Pitts, Vincent Kowal, Jerson Castillo, Tyson Hare. Not present: John Bagnasco, Greg Burley, Christopher Burns, Paul Collison, Alan Dressler, Jonathan Kern, Minjin Kim, Juna Kollmeier, Ivo Labbé, Zhaoyu Li, Andrew McWilliam, Karín Menéndez-Delmestre, David Murphy, Jesper Rasmussen, Michael Rauch, Allan Sandage, Stephen Shectman, Jeanette Stone, Ian Thompson.

The Observatories

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Wendy Freedman, *Director*
Luis Ho
Juna Kollmeier[1]
Patrick McCarthy
Andrew McWilliam
John Mulchaey
Augustus Oemler, Jr., *Director Emeritus*
Eric Persson
George Preston, *Director Emeritus*
Michael Rauch
Allan Sandage, *Staff Member Emeritus*
François Schweizer
Leonard Searle, *Director Emeritus*
Stephen Shectman
Ian Thompson
Ray Weymann, *Director Emeritus*

Research Associates

Dan Kelson, *Staff Associate*
Barry Madore, *Senior Research Associate*

Technical Staff Members

Matthew Johns, *Associate Director of the Observatories*
Alan Uomoto, *Magellan Technical Manager*

Postdoctoral Fellows and Associates

Lei Bai, *Postdoctoral Associate*[2]
George Becker, *Postdoctoral Associate*[3]
Christopher Burns, *Postdoctoral Associate*
Jeffrey Crane, *Carnegie Fellow*[4]
Inese Ivans, *Carnegie-Princeton Fellow*[3]
Daisuke Kawata, *Postdoctoral Associate*[5]
Andreas Koch, *P/T Research Associate*[6]
Ivo Labbé, *Hubble Fellow*
Janice Lee, *Hubble Fellow*
Zhao-Yu Li, *Research Assistant*[7]
Jennifer Marshall, *Carnegie Fellow*[8]
Karín Menéndez-Delmestre, *NSF Fellow*[9]
Ivelina Momcheva, *Postdoctoral Associate*[10]
Andy Monson, *Postdoctoral Associate*[11]
Masami Ouchi, *Carnegie Fellow*
Jesper Rasmussen, *Chandra Fellow*
Jane Rigby, *Spitzer Fellow*
Mark Seibert, *Postdoctoral Associate*
Joshua Simon, *Carnegie-Vera Rubin Fellow*[12]
Laura Sturch, *Research Assistant*
Violet Taylor, *Postdoctoral Associate*
Haojing Yan, *Physical Scientist Associate*[6]

Las Campanas Research Staff

Mark Phillips, *Associate Director, Las Campanas Observatory and Magellan Telescopes*
Miguel Roth, *Director, Las Campanas Observatory*

Las Campanas Fellows and Associates

Ricardo Covarrubias, *Magellan Fellow*
David Floyd, *Magellan Fellow*
Gaston Folatelli, *Postdoctoral Fellow*
Maximilian Stritzienger, *Postdoctoral Fellow*

Las Campanas Visiting Investigator

Nidia Morrell, *Visiting Scientist*

Support Scientist

David Murphy, *Instrument Scientist*

External Affairs, Pasadena

Arnold Phifer, *Regional Director of Advancement*

Giant Magellan Telescope Organization (GMTO)

John Bagnasco, *Senior Opto-Mechanical Engineer*[13]
Charlie Hull, *Project Mechanical Engineer*[14]
Matthew Johns, *Project Manager*[15]
Jonathan Kern, *Telescope Engineering Manager*[16]
Patrick McCarthy, *Director*[9]
Stephen Shectman, *Project Scientist*[17]
Eli Slawson, *GMT Assistant*[18]
Amnon Talmor, *Project Engineer*[19]

Supporting Staff, Pasadena

Alan Bagish, *Las Campanas Observatory Engineer*
Christoph Birk, *Data Acquisition Programmer*

Jerson Castillo, *Instrument Maker*
Ken Clardy, *Programmer*
Paul Collison, *Computer Systems Manager*
Jorge Estrada, *Electronics Technician*
John Grula, *Head Librarian, Information Services/Publications Manager*
Tyson Hare, *Mechanical Engineer*
Earl Harris, *Shipping and Receiving Specialist*[20]
Silvia Hutchison, *Assistant to the Director*
Ayako Jinno-Kanayama, *Financial Accountant*[9]
Sharon Kelly, *Buyer*
Minjin Kim, *Research Assistant*
Vincent Kowal, *Machine Shop Foreperson/Instrument Maker*
Becky Lynn, *Secretary*
Luis Ochoa-Ramirez, *Accounts Payable Specialist*
Greg Ortiz, *Assistant, Buildings and Grounds*
Robert Pitts, *Assistant, Buildings and Grounds*
Vgee Ramiah, *Business Manager*
Judith Rosenau, *Special Projects Coordinator*[21]
Scott Rubel, *Associate Facilities Manager*
Jeanette Stone, *Purchasing Manager*
Robert Storts, *Instrument Maker*
Edward Villanueva, *Data Analyst and Programmer*[22]
Gregory Walth, *Data Analyst*[23]
Steven K. Wilson, *Facilities Manager*

Supporting Staff, Las Campanas

Miriel Abarca, *Janitor*
Carolina Alcayaga, *Purchasing Officer*
Ricardo Alcayaga, *Mechanic*
Juan Alfaro, *Magellan Site Maintenance Support*
Hernán Ángel, *Driver/Purchaser*
Jorge Araya, *Magellan Telescope Operator*
Hector Balbontín, *Chef*
Luis Boldt, *Research Assistant*
Jorge Bravo, *Magellan Instrument Specialist*
Pedro Carrizo, *Plumber*
Jilberto Carvajal, *El Pino Guard*
Jorge Castillo, *Paramedic*
Pablo Castro, *Telescope Controls Programmer*[24]
Emilio Cerda, *Magellan Electronics Engineer*
Carlos Contreras, *Science Support*[3]
Angel Cortés, *Accountant*
Henry Cortés, *Electrician*
José Cortés, *Janitor*
Miguel Cortés, *Mechanic*[25]
Jorge Cuadra, *Mechanic Assistant*
Oscar Duhalde, *Mechanical Technician*
Julio Egaña, *Painter*
Juan Espoz, *Mechanic*
Glenn Eychaner, *Telescope Systems Programmer*
Francisco Figueroa, *Supervisor of Mountain Maintenance*[26]
Carlos Flanega, *Janitor*
Javier Fuentes, *Night Assistant*
Jaime Gómez, *Accounting Assistant*
Pablo Gómez, *Supervisor, Mountain and El Pino Maintenance*[27]
Danilo González, *El Pino Guard*
Luis González, *Janitor*
Sergio González, *Science Support*[28]
Javier Gutiérrez, *Mechanical Technician Assistant*
Nelson Ibacache, *Mechanical Assistant*
Patricio Jones, *Magellan Electronics Engineer*
Oscar Juica, *Plumber*
Marc Leroy, *Assistant Telescope Engineer*
Alejandro Leyton, *Electrician*
Leonel Lillo, *Carpenter*
Gabriel Martin, *Magellan Instrument Specialist*
Mauricio Martinez, *Magellan Telescope Operator*
Miguel Méndez, *Mechanical Technician*
Victor Meriño, *Magellan Instrument Specialist*
Emma Molina, *Administrative Assistant*[29]
Mario Mondaca, *P/T El Pino Guard*
César Muena, *GMT Site Testing Support*
Eric Muñoz, *Accountant*
Pascual Muñoz, *Chef*
Silvia Muñoz, *Business Manager*
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Hernán Nuñez, *Magellan Telescope Operator*
Miguel Ocaranza, *Administrative Assistant*
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David Osip, *Magellan Instrumentation Scientist*
Povilas Palunas, *Telescope Scientist*
Frank Perez, *Site Manager/Telescope Engineer*
Patricio Pinto, *Electronics Engineer*
Gabriel Prieto, *GMT Site Testing Support*
Félix Quiroz, *Mechanical Technician*
Andres Rivera, *Electronics Engineer*
Hugo Rivera, *Magellan Telescope Operator*
Javier Rivera, *Paramedic*
Herman Rojas, *Web Page Specialist*[26]
Honorio Rojas, *Water Pump Operator*
Jorge Rojas, *Janitor*
Felipe Sanchez, *Telescope Controls Programmer*
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Dawn Erb, *University of California, Santa Barbara*
Catherine Espaillat, *University of Michigan*
Pablo Espinoza, *University of Arizona*
Juan Espoz, *Universidad Arturo Prat, Chile*
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Cecilia Fariña, *Universidad Nacional de La Plata, Argentina*
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Knox Long, *Space Telescope Science Institute*
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Mercedes López-Morales, *Department of Terrestrial Magnetism*
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Sangeeta Malhotra, *Arizona State University*
Anna Marino, *Pontifica Universidad Católica de Chile*
Phillip Massey, *Lowell Observatory*
Mario Mateo, *University of Michigan*
Yuichi Matsuda, *Durham University, UK*
Michael McDonald, *University of Maryland*
Brian McLeod, *Harvard University, CfA*
Claudia Mendes De Oliveira, *University of Michigan*
Rene Mendez, *Universidad de Chile*
Emily Mercer, *University of Michigan*
Gabriela Michalska, *Universidad de Concepción, Chile*
Antonino Milone, *Pontifica Universidad Católica de Chile*
Millaray Miranda, *Universidad de Chile*
Margaret Moerchen, *European Southern Observatory*
Lorenzo Monaco, *Universidad de Concepción, Chile*
Ivelina Moncheva, *Pontifica Universidad Católica de Chile*
Marcelo Mora, *University of Valparaiso, Chile*
Nick Mostek, *Lawrence Berkeley National Laboratory*
Veronica Motta, *University of Valparaiso, Chile*
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Tim Norton, *Harvard University, CfA*
Priscilla Nowajewski, *Universidad de Chile*
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Woytek Pych, *Copernicus Foundation*
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Hernan Quintana, *Pontifica Universidad Católica de Chile*
Rick Ragan, *University of Arizona*
Alberto Rebassa, *University of Valparaiso, Chile*
Neil Reid, *Space Telescope Science Institute*

Andreas Reisenegger, *Pontifica Universidad Católica de Chile*
Armin Rest, *Harvard University, CfA*
Mark Reynolds, *University of Michigan*
James Rhoads, *Arizona State University*
Gijsbert Roelofts, *Harvard University, CfA*
Justin Rogers, *The Johns Hopkins University*
Santiago Roland, *Universidad de la Republica, Uruguay*
John Roll, *Harvard University, CfA*
Alexandru Roman, *Universidad de La Serena, Chile*
Gisela Romero, *University of Valparaiso, Chile*
Gregory Ruchti, *The Johns Hopkins University*
Gregory Rudnick, *National Optical Astronomical Observatory*
Jonathan Ruel, *Harvard University, CfA*
Francisco Salgado, *National Science Foundation*
Samir Salim, *National Optical Astronomical Observatory*
Ricardo Salinas, *Universidad de Concepción, Chile*
Wallace Sargent, *California Institute of Technology*
Pal Sari, *HAT-South Collaboration*
Claudia Scarlata, *California Institute of Technology*
Emily Schaller, *University of Hawaii*
Paul Schechter, *Massachusetts Institute of Technology*
Linda Schmidtobreick, *European Southern Observatory*
Alex Schwarzenberg-Czerny, *Copernicus Foundation*
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Anil Seth, *Harvard University, CfA*
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Evgenya Shkolnik, *Department of Terrestrial Magnetism*
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Matt Smith, *Massachusetts Institute of Technology*
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Alicia Soderberg, *Harvard University, CfA*
Marcin Sokolowski, *Andrzej Soltan Institute for Nuclear Studies, Poland*
Brian Stalder, *Harvard University, CfA*
Jay Strader, *Harvard University, CfA*
Vincent Suc, *HAT-South Collaboration*
Andrew Szentgyorgyi, *Harvard University, CfA*
Olaf Szewczyk, *Universidad de Concepción, Chile*
Mauricio Tapia, *Universidad Nacional Auótonoma de México*
Claus Tappert, *Pontifica Universidad Católica de Chile*
Brian Taylor, *Lowell Observatory*
John Tobin, *University of Michigan*
Andrei Tokovinin, *National Optical Astronomical Observatory*
Odette Toloza, *University of Valparaiso, Chile*
Gregory Tompkins, *University of Lethbridge, Canada*
Andrea Torres, *Universidad Nacional de La Plata, Argentina*
Christy Tremonti, *University of Arizona*
Chad Trujillo, *Gemini Observatory*
Miguel Urbaneja, *Universidad de Concepción, Chile*
Janusz Uzycki, *Andrzej Soltan Institute for Nuclear Studies, Poland*
Sylvain Veilleux, *University of Maryland*
Celia Verdugo, *Universidad de Chile*
Sandro Villanova, *Universidad de Concepción, Chile*
Kaspar von Braun, *California Institute of Technology*
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Benjamin Weiner, *University of Arizona*
Jessica Werk, *University of Michigan*
Andrew West, *Massachusetts Institute of Technology*
Christopher Willmer, *University of Arizona*
Steven Willner, *Harvard University, CfA*
Frank Winkler, *National Optical Astronomical Observatory*
Joshua Winn, *Massachusetts Institute of Technology*
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Yujing Yang, *University of Arizona*
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Hans Zinnecker, *Astrophysikalisches Institut Potsdam, Germany*
Kamil Zloczewski, *Nicolaus Copernicus Astronomical Center, Poland*
Manuela Zoccalli, *Pontifica Universidad Católica de Chile*
Monica Zorotovic, *Pontifica Universidad Católica de Chile*

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[1]From September 1, 2008; formerly Carnegie-Princeton Hubble Fellow
[2]From September 22, 2008
[3]To August 31, 2008
[4]From September 1, 2008; formerly postdoctoral associate
[5]To September 26, 2008
[6]To September 30, 2008
[7]From October 16, 2008
[8]To August 15, 2008
[9]From October 1, 2008,Patrick McCarthy has a joint appointment with Carnegie and GMTO
[10]From May 1, 2009
[11]From June 5, 2009
[12]From November 1, 2008
[13]From August 1, 2008
[14]From July 1, 2008; formerly Magellan supporting staff, Pasadena
[15]No date provided
[16]From March 1, 2009
[17]From March 19, 2009, Stephen Shectman has a joint appointment with Carnegie and GMTO
[18]Formerly supporting staff, Pasadena
[19]From June 1, 2009
[20]From July 15, 2008; formerly clerk
[21]To March 27, 2009
[22]From September 16, 2008
[23]To July 31, 2008
[24]From August 12, 2008
[25]From July 15, 2008
[26]From September 1, 2008
[27]To July 15, 2008
[28]To June 5, 2009
[29]From May 4, 2009
[30]To December 31, 2008

DEPARTMENT OF PLANT BIOLOGY First row (left to right): Wenqiang Yang, Zhiyong Wang, Sue Rhee, Peifen Zhang, Bi-Huei Hou, Claudia Catalonotti, Nik Pootakham, Shaoling Xu, Guillaume Pilot, Sairupa Paduchri, Bindu Ambaru, unknown visitor, Zhiping Deng, Paul Sterbentz. Second row: Angelica Vazquez, Sylvie LaLonde, Kathi Bump, Tanya Beradini, Sam Parsa, Viviane Lanquar, Cynthia Lee, Devaki Bhaya, Maria Sardi, Hitomi Takanaga, Yaqi Hao, Jianxiu Shang, Min Yuan. Sitting on side: Chris Wilks, Aung-Kyaw Chi; Third Row: Kun He, Zhiguang Zhao, Tonglin Mao, Mingyi Bai, Guido Grossman, Chang You, Tae-Wuk Kim, Nicole Newell, Evana Lee, Dahlia Wist, Naoia Williams, Diane Chermak, Susanne Wisen, Susan Cortinas, Tian Li, Donghui Li, Bob Muller, Tie Liu, Wolf Frommer, Larry Plotz. Back row: Lee Chae, Peng Xu, Dave Ehrhardt, Ryan Guteirrez, Hulya Aksoy, Sunita Patel, Turkan Eke, David Gonzalez, Clayton Coker, Rosario Gomez, Blaise Hamel, Kate Dreher, Vanessa Swing, Leonardo Magneschi, Glenn Ford, Karthik Karthikeyan, Eva Huala, Ismael Villa, David Swarbreck, Raj Sasidharan, Matt Evans, Kathy Barton.

Plant Biology

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David Ehrhardt
Wolf B. Frommer, *Acting Director,*[1] *Director*[2]
Arthur R. Grossman
Seung Y. Rhee
Christopher R. Somerville, *Director*[3]
Shauna C. Somerville[3]
Zhi-Yong Wang

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Devaki Bhaya
Matthew Evans
Eva Huala[4]

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Ulrich Kutschera, *University of Kassel, Germany*
Tonglin Mao, *Chinese Agricultural University, China*[6]
Iben Møller-Hansen, *University of Copenhagen, Denmark*[7]
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[1]To March 30, 2009
[2]From April 1, 2009
[3]To March 15, 2009
[4] From July 1, 2008
[5] To November 27, 2008
[6]From November 1, 2008
[7]To June 30, 2008
[8]From March 2, 2009, to April 30, 2009
[9]To December 12, 2008
[10]From November 3, 2008, to February 28, 2009
[11]From June 18, 2008, to July 7, 2008
[12]From June 11, 2008, to September 26, 2008
[13]From August 1, 2008
[14]From October 1, 2008
[15]From July 14, 2008
[16]To September 30, 2008
[17]From May 1, 2009
[18]From March 1, 2009
[19]To August 31, 2008
[20]To April 30, 2009
[21]From December 15, 2008
[22]To June 30, 2009
[23]From June 30, 2009
[24]To March 31, 2009
[25]To October 15, 2008
[26]To March 19, 2009
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[28]To June 10, 2009
[29]From September 1, 2008, to January 30, 2009
[30]From September 1, 2008
[31]From June 16, 2008, to November 1, 2008
[32]From July 1, 2008, to November 1, 2008
[33]To April 18, 2009
[34]From June 16, 2009
[35]From July 1, 2008, to September 30, 2008
[36]From August 18, 2008, to June 30, 2009
[37]From June 2, 2008, to August 1, 2008
[38]From October 2, 2008
[39]From June 19, 2008, to August 31, 2008
[40]From July 2, 2008, to August 31, 2008
[41]From June 17, 2008, to August 31, 2008
[42]To July 31, 2008
[43]From June 23, 2008, to September 30, 2008
[44]From July 1, 2008, to November 7, 2008
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[46]From October 20, 2008
[47]From June 19, 2008, to August 31, 2008
[48]From June 23, 2008, to September 30, 2008
[49]To November 1, 2008
[50]From June 20, 2008, to September 30, 2008
[51]From October 29, 2008, to December 15, 2008
[52]From November 20, 2008
[53]From January 26, 2009
[54]To September 19, 2008

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Photo taken on November 2, 2009. Image courtesy Mike Colella

[1] Killed on August 7, 2009
[2] To September 5, 2008
[3] From September 1, 2008
[4] To October 1, 2008
[5] From August 1, 2008
[6] From August 1, 2008
[7] To December 15, 2008
[8] To October 15, 2008
[9] To October 31, 2008
[10] To November 15, 2008
[11] From September 3, 2008
[12] NAI Fellow From February 1, 2009
[13] To September 20, 2008
[14] From November 24, 2008
[15] Joint appointment with Geophysical Laboratory
[16] Died November 23, 2009
[17] From August 13, 2008
[18] To May 15, 2009

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July 1, 2008 - June 30, 2009

EMBRYOLOGY

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GEOPHYSICAL LABORATORY

Here updated through September 30, 2009. The list is regularly updated on the Geophysical Laboratory Web site (http://www.gl.ciw.edu).

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